POLYESTER RESIN/ FIBERGLASS

Compliance Assistance Program

California Environmental Protection Agency
Air Resources Board

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101 AIR RESOURCES BOARD

Air Quality Program

California leads the nation in cleaning up the air. In 1955 the Bureau of Air Sanitation began identifying the air pollution levels that could endanger public health. Recognizing cars and trucks as a major cause of smog problems, the State formed the Motor Vehicle Pollution Control Board (MVPCB) in 1960 to regulate tailpipe emissions. California was the first state to adopt vehicle emission standards for hydrocarbons (HC) and carbon monoxide (CO).

ARB Created

In 1967 the MVPCB and the Bureau of Air Sanitation were combined to create the Air Resources Board (ARB). With this merger, the authority to define the health threat of air pollution and to regulate its causes was united in a single organization. Since then, the ARB, working with county air pollution control districts (APCDs) and regional air quality management districts (AQMDs) has created one of the world's most comprehensive air quality control programs.

In July 1991 the California Environmental Protection Agency was formed to bring together under a single, accountable, Cabinet level agency these entities: the Department of Pesticide Regulation, the Department of Toxic Substances Control, the Office of Environmental Health and Hazard Assessment, the Integrated Waste Management Board, the State Water Resources Control Board, nine Regional Water Quality Control Boards, and the Air Resources Board.

What does the ARB do? As the primary statutory authority, the ARB establishes and enforces standards to limit pollutant emissions from motor vehicles. The ARB also:

What Does ARB Do?

- Conducts inspections to ensure compliance with air pollution regulations by applying **consistent and evenhanded enforcement;**

- Develops rules and regulations to assist local air pollution control districts in their efforts to maintain air quality standards;

- Establishes air quality standards which identify acceptable concentrations of specific pollutants which are intended to protect the health of vulnerable members of the general population and to prevent property and crop damage;

- Monitors air quality throughout the State;

- Evaluates the effectiveness of pollutant control strategies both for automobiles and industrial sources; and,

- Conducts extensive research programs.

The ARB's past efforts have reduced the pollution emitted from vehicles and other large sources. Now, and for the future, the ARB is focused on smaller, individual sources of pollution. However, successfully regulating a very large number of very small, diverse sources poses even greater challenges than previous clean air measures; continuing to improve the air quality requires hard work and careful planning.

102 COMPLIANCE ASSISTANCE PROGRAM

Compliance Assistance Program (CAP)

The Compliance Assistance Program (CAP), created in 1988 by the ARB, assists local air pollution control districts in conducting more comprehensive, consistent, and accurate facility compliance inspections. The CAP also provides industry with information and tools, in the form of self-help publications, which clarify compliance requirements and help explain how to stay in compliance with air pollution rules and regulations. The CAP also assists industries in establishing their own compliance inspection programs. By conducting routine compliance inspections, industrial emissions sources can stay in compliance on a daily basis and can thereby avoid costly air pollution violations.

Through the development and distribution of rule-specific publications, the CAP creates an effective flow of information in a variety of useful formats. Based on the idea that sources will comply if they can understand what is required of them, CAP publications identify regulation requirements and present them in more readily readable formats.

Publications

Publication formats include:

Handbooks. Easy to read, colorfully illustrated handbooks are developed for the industrial labor force and the interested public. Most can be read in ten minutes or less and most contain helpful self-inspection checklists.

Pamphlets. Quick reference pamphlets are filled with detailed flow charts, checklists and informative diagrams. These are designed for facility managers, plant personnel and industry's environmental managers.

Technical Manuals. Detailed technical inspection manuals are developed for local air pollution control district inspectors and industry's environmental managers. These contain rule information, process descriptions, and step-by-step compliance inspection procedures.

CAP Goals

In 1988 California enacted legislation known as the California Clean Air Act. This act requires the air pollution control districts to attain the State and Federal ambient air quality standards at the earliest practicable date, and requires each air pollution control district to prepare a plan showing how it will achieve this.

Enforcement audits of certain industrial source types (such as solvent degreasers, gasoline vapor recovery systems, and coating of metal parts) show that noncompliance rates can be as high as 50 percent. Noncompliance results in excessive emissions.

Traditionally, ARB has sought to reduce noncompliance rates by providing an adequate deterrent through enforcement action against violators. In addition, ARB now seeks to reduce noncompliance rates and the associated excess emissions by ensuring that source operator knowledge includes:

- A basic understanding of the rules to which the source or product is subject; and,

- A basic understanding of how compliance is to be determined.

If California's nonattainment areas are to have any chance of achieving the ambient air quality standards, the excess emissions resulting from noncompliance must be reduced with the help of both air pollution control inspectors and industry personnel. Air pollution control inspectors can identify problems for the source operator and propose corrective action, but their periodic visits cannot ensure continuous compliance. Compliance is the job of educated source operators. The goal of the Compliance Assistance Program is thus twofold:

- To help air pollution control districts develop and maintain inspector knowledge; and

- To encourage industry to conduct self-inspections for continuous compliance.

102.1 FOCUS: TARGET AUDIENCE

Who Will Use This Manual?

The primary focus of the CAP is to improve the knowledge of inspectors and industrial operators. In order to reduce noncompliance and excess emissions, both the inspector and the operator need to know what is regulated, why it is regulated, and how compliance is determined. Thus, this manual was written primarily for district field operation staff, district permitting staff, and environmental managers, but it may also be useful to other government agencies and industry personnel. It can be used as a reference manual or user's guide and it is designed for easy referencing, reading, and updating. It also contains illustrations and tables to enhance understanding.

103 MANUAL SCOPE AND ORGANIZATION

Manual Description

This manual is designed to assist local air pollution control district inspectors in conducting complete, consistent, and efficient compliance inspections. It is also designed to supplement, but not replace the operating manuals and various operator training courses that vendors provide their clients.

This manual contains a description of the processes and emission control technologies, a discussion of regulatory requirements at the Federal, State and local levels, and a detailed description of facility inspection procedures. Also contained in this manual are a glossary and air pollution control definitions and terms, appendices with additional reference material which can be reproduced for use in the field, and a comprehensive index.

This manual is designed to address the equipment, operations, and air pollution control regulations applicable in the State of California.

As a reference document, this manual is divided into numbered sections and subsections, with key topic words identified in the outside scholar margins.

104 MAINTENANCE OF MANUAL

Comments or Questions

This manual is a dynamic reference document. To keep this manual accurate and current, CAP staff rely heavily on district inspector experience and industry personnel expertise. As changes or improvement issues concerning this technical manual are raised, users should make note of them. All comments should then be forwarded to:

Air Resources Board
Compliance Division
Compliance Assistance Program
P.O. Box 2815
Sacramento, California 95812

Comments are reviewed as they are received and if any proposed amendments need immediate attention, changes will be made as soon as possible. A draft of the revised technical manual will then be provided for comment to all local districts. For proposed changes which are less critical, several will be accumulated before any changes are made. If regulations change significantly or new information on equipment and processes become significant, a technical manual update package will be prepared and sent to all users who have completed and returned a Manual Tracking Card.

Manual Tracking Card

A Manual Tracking Card is located at the front of this manual. It is important that each recipient of one of these manuals complete and return a card to the address listed previously. Technical manual upgrade packages will only be sent to those who have completed and returned this card.

200 CATEGORY DESCRIPTION

SIC Codes

This section provides background information on the size, geographic distribution, employment, production, sales and economic condition of the plastic resin and manmade fiber industries. Facilities described within this document are described in terms of their Standard Industrial Classification (SIC) codes, even though it is difficult to classify the fiberglass-reinforced and composite (FRP/C) industry by SIC because it crosses several industrial categories, ranging from household vanity installations to complex structural composites for the aerospace industry.

201 HISTORY OF THE PLASTIC RESIN AND MANMADE FIBER INDUSTRIES

History of Plastic Resin Industries

Plastics today are one of the most used materials in U.S. industrial and commercial life. Some of the more common industries that fabricate fiberglass and composite plastics as part of the manufacturing process are the automotive, ship and boat building (SIC codes 3731 and 3732), aerospace and miscellaneous

Resin Consumption by Market

Table 200.1: Consumption of Fiberglass-Reinforced Polyester Resin by Market (1990)

	Millions of Pounds/Year	Fabricated Value Million $
Aircraft/Aerospace	34	408
Appliances/Business equipment	93	279
Construction	384	1,729
Consumer products	127	572
Corrosion-resistant products	336	2,688
Electrical	53	132
Marine	300	2,400
Transportation	215	1,075
Other	48	192
Total	1,590	9,474

Source: Fiberglass Fabrication Association

200 CATEGORY DESCRIPTION

plastics products industry (SIC codes 3081 to 3089). Table 200.1 shows the consumption of fiberglass reinforced polyester resin in 1990 by major market, along with the estimated value of products.

201.1 THE ORIGIN OF PLASTIC RESINS

Origin of Plastic Resins

The first plastics were invented in the 1800s when people experimented to produce everyday objects out of alternative materials. The first plastic was developed in 1851 when hard rubber, or ebonite, was synthesized. This was the first material that involved a distinct chemical modification of a natural material. Table 200.2 lists selected plastic resins and synthetic fibers by year of development and their principal uses.

Table 200.2: Introduction of Selected Plastic Resins and Manmade Fibers

Year	Material	Example
1868	Cellulose Nitrate	Eyeglass frames
1900	Viscose Rayon	Lining in clothing, curtains
1909	Phenol-Formaldehyde	Telephone Handset
1927	Cellulose Acetate	Toothbrushes, lacquers
1927	Polyvinyl Chloride	Wall Covering, pipe, siding
1936	Acrylic	Brush Backs, display signs
1938	Polystyrene	Housewares, toys
1939	Nylon	Fibers, films, gears
1942	Low Density Polyethylene Unsaturated Polyester	Packaging, squeeze bottles Boat Hulls
1952	Polyethylene Terephthalate	Clothing, fiberfill
1957	Polypropylene	Safety Helmets
1964	Polyimide	Bearings
1970	Thermoplastic Polyester	Electrical/Electronic parts
1978	Linear Low Density Polyethylene	Extruded film
1985	Liquid Crystal Polymers	Electrical/Electronic Parts

Source: This table has been adapted from *Facts and Figures of the U.S. Plastics Industry*, (1995 Edition) prepared annually by The Society of the Plastics Industry, Inc., Washington, D.C. Please refer to that document for a more complete listing of plastic resin development.

The first plastics in the U.S. were developed while John Wesley Hyatt was experimenting to produce a billiard ball from materials other than ivory. In 1870, John and his brother Isaiah took out a patent for a process producing a horn-like material using cellulose nitrate and camphor.

Another important precursor to modern plastics was the development of formaldehyde resins. Early experiments to produce white chalkboards in Germany around the turn of the 20th century led to the development of formaldehyde resins. These resins were first produced by reacting casein (milk protein) with formaldehyde.

Thermoplastics

During the 1930s, the initial commercial development of today's major thermoplastics took place. These included polyvinyl chloride, low density polyethylene, polystyrene, and polymethyl methacrylate. Demand for plastics escalated during World War II when substitutes for scarce natural materials, like rubber, were in high demand. Large-scale production for synthetic rubbers triggered extensive research into polymer chemistry and new plastic materials.

In the 1940s, polypropylene and high density polyethylene were developed, and in 1978, linear low density polyethylene was developed. Large-scale production of these materials reduced their cost substantially, which allowed these new plastics materials to compete with traditional materials like wood and metal. The introduction of alloys and blends of various polymers has made it possible to tailor properties to fit certain performance requirements that a single resin could not provide. Demand for plastics has steadily increased, and now plastics are accepted as basic materials along with the more traditional materials in designs and engineering plans (SPI, 1995).

201.2 THE ORIGIN OF MANMADE FIBERS

In 1664, Robert Hooke first suggested that manmade yarn could be produced. He speculated, in *Micrographia*, that synthetic fibers could be patterned after the excretion of silk by silkworms.

Synthetic Fibers

> And I have often thought, that probably there might be a way, found out, to make an artificial glutinous composition, much resembling, if not full as good, nay better, than the Excrement, or whatever other substances it be out of which, the Silk-worm winds and draws his clew. If such a composition were found, it were certainly an easier matter to find very quick ways of drawing it into small wires for use (Linton, 1966).

During the 19th century, scientists were busy making precursor solutions of the first manmade fibers, cellulosic fibers. In 1840, F. Gottlob Keller of Germany devised a technique for making pulp for paper by squeezing powdered wood taken from a grindstone. This enabled the future production of rayon and other cellulosic items. During that same year, Louis Schwabe, an English silk manufacturer, developed the first spinnerette through which a spinning solution could be extruded (Linton, 1966).

Nylon

In 1926, Du Pont Laboratories began a chemical research program that led to the advent of the synthetic, or noncellulosic, fiber industry. Unlike cellulosic fibers, synthetic fibers are wholly compounded from chemicals. The first synthetic fiber that Du Pont developed was Fiber 66. Now known as nylon (6,6), the fiber began widespread production for markets, such as nylon hosiery, in 1939. During World War II, nylon was used in producing parachutes, uniforms, and a host of other military equipment. Started primarily as a hosiery yarn, the use of nylon spread after the war into other applications like carpeting and woven fabrics.

Wrinkle-resistant and strong, the first polyester fiber, Terylene, was developed by a British scientist group called the Calico Printers Association. In 1946, Du Pont secured exclusive rights to produce this polyester fiber in the U.S. In December 1950, Du Pont announced plans to build its first plant at Kinston, North Carolina at a capacity of 36 million pounds a year at a cost of $40 million. Du Pont unveiled the new fiber, named Dacron, at a famous press conference where it was displayed in a swimsuit that had been worn 67 days continuously without ironing. After polyester fibers were first produced commercially in the U.S. in 1953, the fibers were rapidly used to make men's suits, women's blouses, and men's shirts.

Since then, most technological advances in manmade fibers have occurred in synthetics, which now make up almost all of the U.S. production of manmade fibers. Synthetic fibers have many advantages to cellulosic fibers, such as controlled shrinkage, crease retention, and wrinkle resistance. Synthetic fibers have developed to seem more natural, softer, easier to care for, more lustrous, and more comfortable.

201.3 HISTORICAL BACKGROUND ON FIBERGLASS

Fiberglass

The industrial fury of the 19th and early 20th centuries gave birth to innumerable revolutionary ideas and inventions that changed the lives of millions. One of the most forward-thinking visions involved creating fibers from glass - one of the world's oldest and most available materials.

Both Owens-Illinois Glass Company and Corning Glass Company had been experimenting with glass fiber technology. Games Slayter, who was the driving force behind the Owens Corning technology and innovation, envisioned a glass fiber material that was not as heavy and full of shot as the then-current technology produced.

In 1932, a young researcher named Dale Kleist, who worked for Jack Thomas (Slayter's research assistant), was attempting to weld together architectural glass blocks to form a vacuum-tight seal. A jet of compressed air accidentally struck a stream of molten glass, resulting in fine glass fibers. Kleist, by accident, had achieved Games Slayter's dream. In the Fall of 1932, Kleist further refined the process by using steam, instead of compressed air, to attenuate glass fibers. Steam is cheaper, he reasoned, and would produce a finer fiber; Kleist was correct. The result was a glass fiber material thin enough to be used as a commercial fiber glass insulation.

In March 1933, Games Slayter asked Jack Thomas to conduct experiments using glass wool, instead of natural fibers, on textile machinery. These experiments indicated the possibility of substituting glass fibers for natural or other synthetic fibers in textile applications. With this experiment began the still-thriving glass fiber textile industry.

Owens Corning

On December 5, 1933, Owens-Illinois, seeing the need for separate facilities for its bottling plants and its glass fiber research and manufacturing facilities, relocated its glass fiber operations to a closed bottling plant in Newark, Ohio. Throughout 1933 and 1934, Owens-Illinois expanded its research and manufacturing facilities in the Newark plant.

In 1935, realizing the potential growth of the glass fiber insulation market, Corning Glass, which had briefly experimented with glass fiber manufacturing in the 1920s, approached Owens-Illinois, asking to share the costs of glass fiber developments, and Owens-Illinois agreed to the proposal. In 1936, Owens-Illinois helped Corning Glass establish experimental glass wool and other equipment at Corning's Corning, New York plant.

"Fiberglas", spelled with one "s" was first used as a trademark of Owens-Illinois in January 1936 on all Owens-Illinois glass fiber products.

In 1938, experimental costs prompted Owens-Illinois and Corning Glass to consider spinning off the joint venture as a separate company. That same year, the patent for glass fiber manufacturing, originally applied for in 1935, was granted to Dale Kleist and Jack Thomas.

200 CATEGORY DESCRIPTION

On November 1, 1938 Owens-Corning Fiberglas® Corporation was announced. By the end of 1938, Owens Corning and the Duplate Safety Glass Company established Fiberglas® Canada in 1939, launching Owens Corning into the international arena. Each founding company held a 50 percent share. Owens Corning would later own the entire Fiberglas® Canada operation.

Warship Insulation

The United States Navy Bureau of Ships in 1939 made Owens Corning insulation the standard insulation for all horizontal and vertical spaces in all new warship construction. By the end of 1939, Owens Corning reported $3.8 million in net sales. Owens Corning employed over 1,000 people by the end of the decade.

In 1941, experiments began with heat cleaning and treating Fiberglas® cloth in Newark. The heat treatment gave the cloth more flexibility, and proved to be a key element in making Fiberglas® fibers suitable for use as reinforcements in plastic laminates.

Throughout World War II, Owens Corning ran at capacity. The principle product was Navy Board, for use in insulating warships. More than 22,000,000 square feet of Navy Board were made in 1942 alone.

As of 1942, White Wool insulation, Navy Wool insulation, Bonded mat, battery separators, sewn blankets, metal mesh blankets and Staple electrical wire insulation were among the products which comprised Owens Corning's production.

Owens Corning partnered with the United States Army Air Force in 1942 to develop low-pressure, plastic laminates for use in structural aircraft parts; these laminates were made from Fiberglas® cloth impregnated with resin.

Reinforced Plastics

In 1944, Owens Corning developed the first Fiberglas® reinforced plastic boat hull; Navy Board production was in excess of 60,000,000 square feet; and highest war time sales of $58,499,000 were achieved.

In 1946, the first Fiberglas® reinforced plastic fishing rods, serving trays and pleasure boats were marketed. The remainder of the 1940s were marked by innovations in Fiberglas® reinforced plastic applications and other product innovations, including the first acoustical tile machine in 1949.

Glass Fiber

Currently, reinforced plastics make up about 5 percent of the total plastic demand, but new developments in blending, compounding, and fabrication will increase the demand for reinforced plastics. Glass fiber is the dominant reinforcing material, representing about 90 percent of reinforcement materials in use. Other common types of reinforcement materials used are aramid and carbon fibers. The glass fiber-reinforced structural composites market is expected to grow at a rate of 10 to 15 percent per year, primarily as a result of its increasing importance in the construction of automotive components.

202 INDUSTRIAL PROCESSES OVERVIEW

Overview of Industry

This technical manual focuses on industrial processes and environmental issues relevant to the plastic resin and manmade fiber industries. These industries were chosen for this manual because they have certain industrial processes in common, such as polymerization and extrusion. Both the plastic resin industry and the manmade fiber industry use refined petroleum products and synthetic organic chemicals to make selected polymers, which are large molecules made up of simple repeating chemical units. Facilities then process the polymers into plastic pellets and manmade fibers. Figures 200.1, 200.2, and 200.3 provide an overview of the raw material inputs, products, and end uses of plastic resin and manmade fiber.

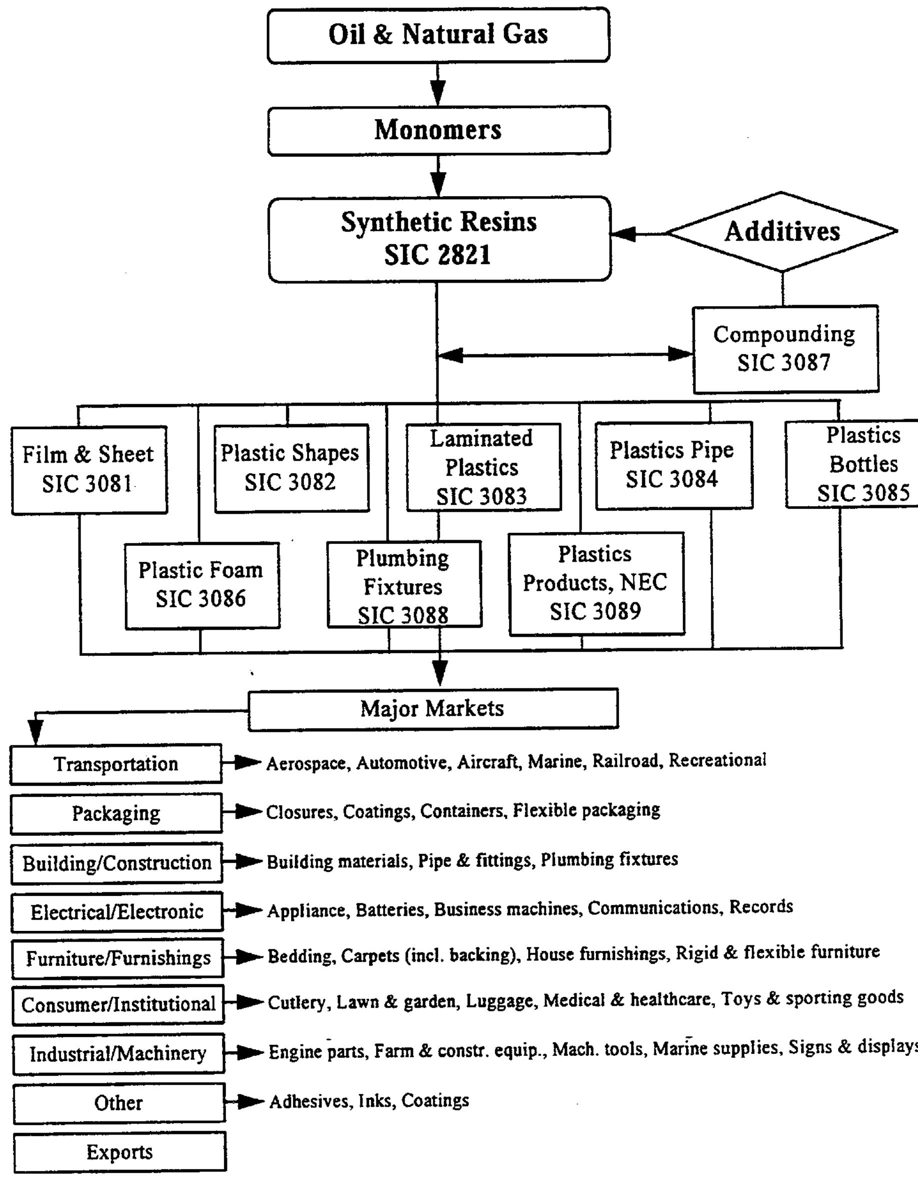
202.1 USES OF POLYESTER RESINS

Products Made From Reinforced Plastics

Polyester resins have a wide array of uses to the industrial sector. Thousands of products are manufactured from reinforced plastics. Fiberglass products have been widely used since World War II due to their high strength and dimensional stability with low weight, good corrosion resistance, and excellent dielectric properties.

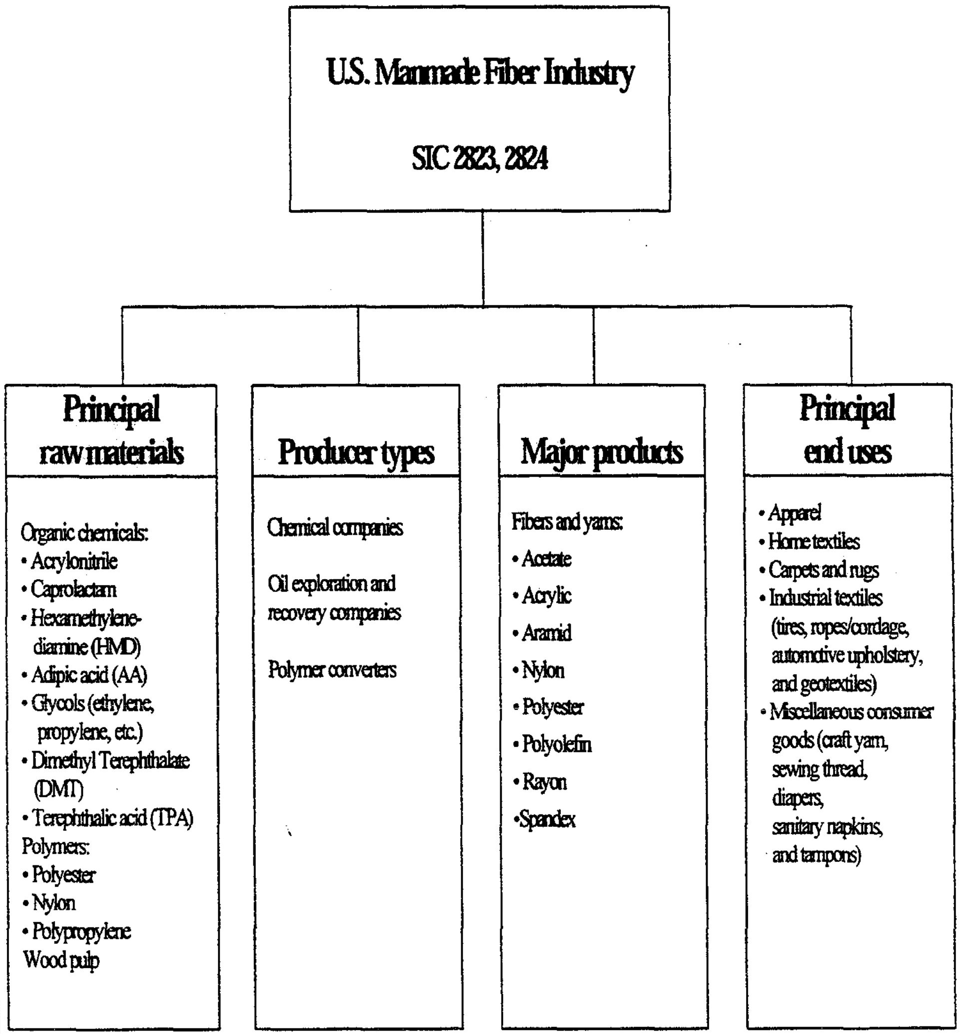
Examples include hulls for recreational and commercial watercraft; bodies for recreational vehicles; building panels; sporting equipment, appliances, and power tools; bathtub, shower, and vanity installations; automotive, aerospace, and aircraft components; and structural components for chemical process equipment and storage tanks. The fiberglass reinforcing in these plastic products improves their structural strength and rigidity, as well as providing high heat resistance and dielectric strength.

200 CATEGORY DESCRIPTION



Source: *Facts and Figures of the U.S. Plastics Industry,* (1995 Edition) prepared annually by The Society of the Plastics Industry, Inc., Washington, DC.

Figure 200.1: Plastic Resins: From raw material to finished product

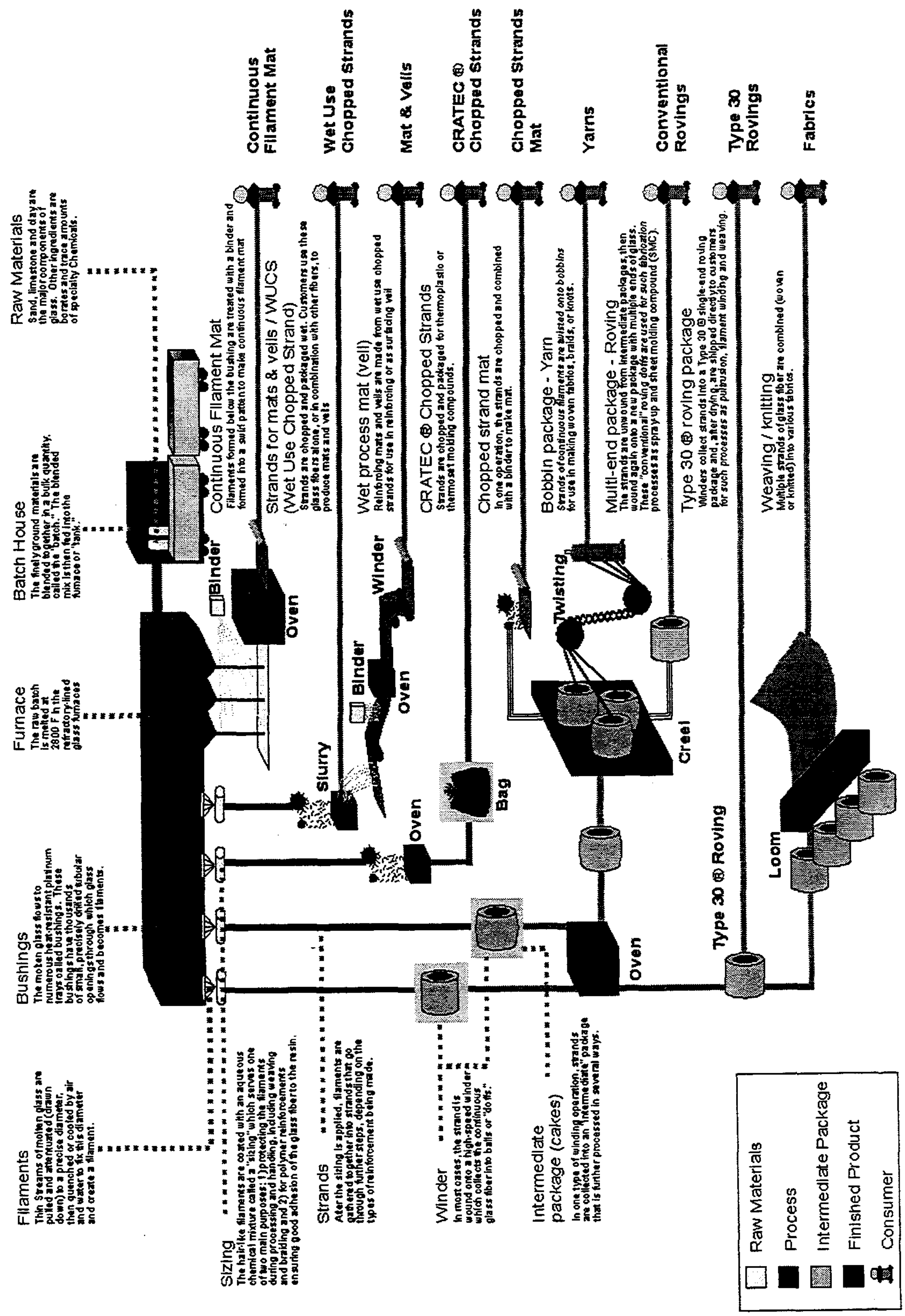


Source: *Industry and Trade Summary: Manmade Fibers,* U.S. International Trade Commission, Washington, DC, 1995

Figure 200.2: U.S. Manmade Fiber Industry: Principal raw materials, producer types, major products, and principal end uses

200 CATEGORY DESCRIPTION

Figure 200.3: How Glass Fibers are Made



Source: Owens Corning

Thermoplastic/ Thermosetting Materials

Plastics can be classified as either thermoplastic or thermosetting. Thermoplastic materials become fluid upon heating above the heat distortion temperature, and, upon cooling, set to an elastic solid. The process of reheating and cooling can be repeated many times, although there may be some degradation in chemical or physical properties of the final product. Thermosetting materials, irreversibly polymerize and solidify at elevated temperatures. The internal chemical structure of a thermosetting plastic material is permanently altered by heat, resulting in a product that cannot be resoftened (Jones and Simon 1983).

Both thermoplastic and thermosetting resins are used to manufacture FRP/C plastic products. Thermoplastics processing offers faster molding cycles, lower emissions during processing, lower cost per pound of raw material, ease of recycling, and lower labor intensity. Open molding of thermosetting plastics is likely to continue as a viable process because of the design constraints associated with many products, limited unit production requirements, performance requirements, and market demands. Recent advances in processing technologies and thermoplastic resin systems are causing the thermoset-plastic industry to examine alternative approaches to molding processes.

Another rapidly growing market for fiber-reinforced structural composite plastics are the automotive and aerospace industries. Composites are becoming or have the potential to become preferred materials for certain passenger car components processed largely from fabricator suppliers (Fishman 1989).

Raw Materials

202.2 RAW MATERIALS

The materials primarily used by the FRP/C plastic product manufacturing industry include resins, fiberglass or other fiber substrate, solvents, catalyst, and other specialty chemical additives. The following is a brief description of each category of raw material.

Resins

202.2.1 Resins

Typical resin classes used by FRP/C manufacturers include: polyesters, epoxies, polyamides, and phenolics. The type of resin to be used in a particular process depends on the specific properties required for the end product. The resin is usually supplied in liquid form, which may include a solvent. For example, polyester is typically dissolved in styrene monomer.

202.2.2 Chemistry of Polyester Resin

Types of Resins

Polyester resin products offer a combination of properties such as high strength and dimensional stability with low weight; corrosion resistance; excellent dielectric properties; opportunities for parts consolidation and design flexibility; low finish cost; and moderate tooling cost.

The fabrication of polyester resin products requires a complex chemical reaction. Table 200.3 compares properties of various types of resins.

Basically, there are two types of resins. The first type is a general-purpose resin. One example is orthophthalic resins, which are used by the majority of the polyester resin fabricators. These orthophthalic resins are lower-cost resins and they satisfy most of the product specification requirements. The second type is corrosion-resistant resins such as halogenated, bisphenol-A, furan, vinyl ester, and isophthalic. These resins are relatively costly and their unique molecular structures allow them to resist acids, alkalies and solvents.

Polyester resin materials have been classified as plastics. Plastics are various synthetic materials chemically created from organic (carbon-based) substances.

There are two basic types of thermoplastics and thermosetting plastics. Thermoplastics are those which can be formed or shaped by heat; this can be done a number of times (physical change). Thermosetting plastics are those which, when formed or reacted, require or give off heat and cannot be reformed (chemical change).

Polyesters

A slightly better classification than plastics is polymers. Polyesters are polymers chained together in a particular order called ester linkages (two carbon and two oxygen atoms).

Polyesters can be broken down into unsaturated and saturated. The term unsaturated refers to a chemical state in which a compound has chemically unsatisfied reactive groups readily available for attachment to other groups. The saturated polyesters are represented by alkyds (oil-based paints) and polyester fibers (cloth, rayon, nylon).

The types and relative ratios of the various raw materials which are incorporated into an unsaturated polyester determine the physical properties of the resin.

Polymer Resins

There are six types of thermosetting polymer resins: isophthalic, orthophthalic, halogenated, bisphenol-A, furan, and vinyl ester. The majority of the fabricators use orthophthalic resins for most of their products. The other resins, called corrosive-resistant resins, which are used in applications that have acid, alkali and solvent-resistant requirements, usually cost more than the general-purpose resin and these applications/end uses may require the Underwriter Laboratories' approval.

Orthophthalic Resins

Orthophthalic resins are often called general-purpose polyester resins. The difference between orthophthalic and isophthalic resins is in the position of the two COOH (carboxyl) groups in the phthalic acid molecule. They are on adjacent carbons (e.g., in the ortho-position) in orthophthalic acid, and are separated by one carbon (e.g., in the meta-position) in isophthalic acid. This resin provides little corrosion resistance.

Isophthalic Resins

Isophthalic resins are either rigid or flexible unsaturated polyester resins and are based on isophthalic acid and glycols of various types. These resins are non-fire-retardant and are used for moderate corrosion-resistance applications up to 180°F. They generally exhibit excellent resistance to water, weak acids, and alkalies; and good resistance to solvents and petroleum products such as gasoline and oil. The flexible isophthalics exhibit a lesser degree of chemical resistance than the rigid isophthalics of higher molecular weight.

Chlorendic Resins

Chlorendic resins are unsaturated halogenated polyester resins based on HET (hexachlorocyclopentadiene) acid or chloredic anhydride reacted with a stable glycol.

This resin is suitable for use at elevated temperatures, up to 350°F and is able to handle aggressive, highly oxidizing environments, concentrated acids and some solvents very well, but is poor in alkaline service. It can be formulated to achieve a Class 1 fire rating.

Bisphenol-A

Bisphenol-A is an unsaturated, rigid polyester made by reacting biphenol-A with propylene oxide to form a glycol, then reacting the glycol with fumaric acid to produce the resin.

This resin exhibits excellent corrosion resistance to both acid and alkali up to 250°F. This is not suitable for strong oxidizing conditions.

200 CATEGORY DESCRIPTION

Vinyl Ester Resins

Vinyl ester resins are methacrylated epoxies that are very similar to polyester. They offer excellent physical strength and, in general, much better impact strength than rigid polyester resins. These resins exhibit excellent resistance to acids, alkalies, hypochlorites and many solvents. They are preferred for filament winding, especially for machine-made piping. Laminates are good up to 250°F.

Furan Resins

Furan resins are based on a furan polymer derivative of furfuryl alcohol. They exhibit excellent resistance to strong alkalies and acids containing chlorinated organics, and are superior in solvent resistance. However, the furan materials are not suitable for oxidizing chemicals and should not be used for chromic or nitric acids, peroxides, or hypochlorites. Laminates are good up to 250°F.

Properties of Resins

Table 200.3: Comparison of Properties of Various Types of Resins

	Isophthalic	Orthophthalic	Halogenated	Bisphenol-A	Furan	Vinyl Ester	Carbon Steel	Stainless Steel
Resistance to Acids	B	C	A	A	A	B	B	B
Resistance to Alkalies	B	C	C	A	A	A	B	B
Resistance to Peroxides	C	C	A	B	C	B	C	C
Resistance to Hypochlorites	C	C	A	B	C	B	C	C
Resistance to Solvents	B	C	B	B	A	B	A	A
Flame Retardance	C	C	A	C	B	C	A	A
Thermal Insulation Ability	A	A	A	A	A	A	C	C
NOTE: A = High; B = Moderate; C = Low								

Source: South Coast Air Quality Management District

As illustrated in Table 200.3, polymer resins do not resist all environments, nor do they respond equally to specific applications.

The types and relative ratios of the various raw materials which are incorporated into an unsaturated polyester determine the physical properties of the resin.

Base Resin

Raw materials are mixed in a specific ratio and are heated (cooked). The cooked material is called a base resin. The base resin is solid at room temperature and is later reduced with monomer (normally styrene) which will thin the polyester and eventually react with it. The monomer reacts with the base resin because the unsaturated groups will react with each other, bridging (cross-linking) the polyester chains together until one solid mass forms. The control of this spontaneous cross-linking reaction is done with chemical additives called inhibitors. Usually enough inhibitor is added to keep the system stable (liquid) for a minimum time (three months at 73 °F).

Polymerization

The cross-linking reaction (polymerization) is a chemical process affected by several factors such as temperature, mass, catalysts, promoters, inhibitors, and contaminants. Most of the polyester resin fabricators use a catalyst in their operation to overcome the inhibitor in order to cause cross-linking of the polyester resin.

202.2.3 Fiber Reinforcement

Glass Fiber Substrates

Glass fiber substrates are manufactured in several forms. The basic forms include continuous-strand mat, chopped strand mat, fabrics (woven and knitted) and continuous strand weaving. The form in which the fiber is used is dependent primarily on the fabrication techniques. Fiberglass content in the product typically ranges from 25 to 60 percent.

202.2.4 Initiators and Catalysts

Curing Agents

In the case of epoxy and polyester resins, curing employs hardeners or catalysts to develop desirable properties. Curing agents include amines, anhydrides, aldehyde condensation products, and Lewis acid catalysts. Aliphatic amines, such as diethylenetriamine and triethylenetetramine, are often used for room temperature curings. Aromatic amines, such as methylenedianiline, are used where elevated temperature cures are acceptable. Formulated epoxy systems generally contain accelerators, additives and fillers to reduce costs, shrinkage, and thermal expansion (California DHS, 1989).

202.2.5 Additives

Additives

Chemical additives are introduced to obtain certain product characteristics such as heat resistance, aging, electrical properties, optical clarity, permeability, flame retardants, and ease of application. Because of the diversity of consumer requirements, additive requirements are often complex. They may include fillers; flame retardants; plasticizers; tougheners and thickening agents; colorants; antioxidants; anti-static compounds and ultraviolet stabilizers. There are literally hundreds of chemicals used as additives. Four functional classes of additives (fillers, plasticizers, reinforcements and colorants) account for about 90 percent of all additives used in plastics. Compared to resins, these materials are generally inert. Except for plasticizers, they are unaffected by light, heat and atmosphere. The remaining 10 percent of plastics additives is dominated by flame retardants.

202.2.6 Solvents

Solvents

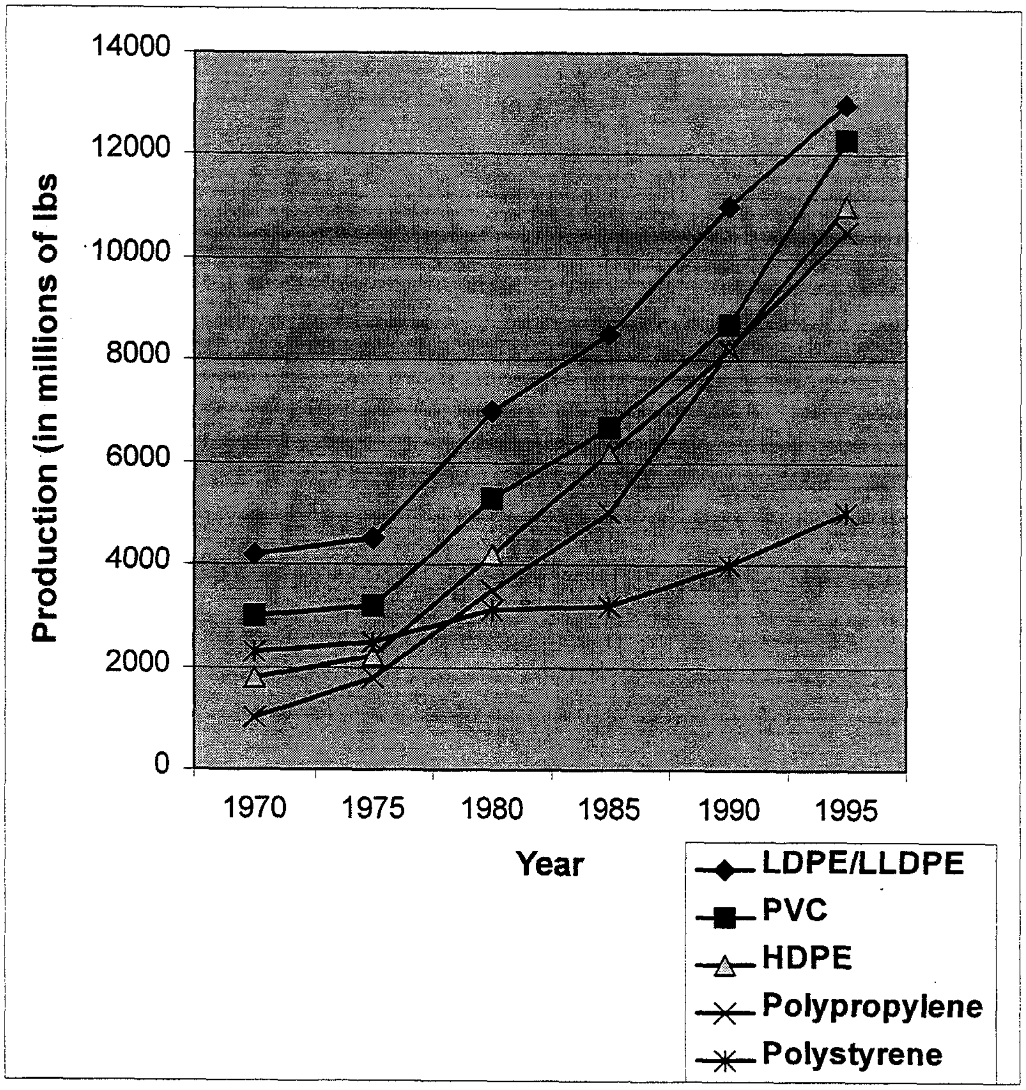
Solvents such as acetone, methyl ethyl ketone and methanol are used in large quantities to clean equipment and tools. Of these, acetone is the most widely used. Many fabricators have begun to replace acetone with dibasic ester (DBE). DBE is a mixture of the methyl esters of adipic, glutaric and succinic acids that is both less volatile and less flammable than acetone (Lucas 1988). Methylene chloride has been used widely for cleaning because it is an effective solvent for many cured resins, although its use has been declining due to health and safety concerns. Styrene is reportedly used by some resin manufacturers to clean equipment, and may be used by fabricators.

203 ECONOMIC OUTLOOK

Economics

203.1 PLASTIC RESIN INDUSTRY

The U.S. is a major exporter of plastics. Figure 200.4 shows trends in U.S. production of selected plastic resins for the past 25 years. Trade with Canada and Mexico accounted for about one-third of total U.S. plastics exports in 1992. Chronic worldwide overcapacity in plastics has continued to depress and slow



Source: U.S. Tariff Commission (for 1970 data); SPI Committee on Resin Statistics as compiled by the Association Services Group (for 1975-1995 data).

Figure 200.4: U.S. Production of Selected Resins, in millions of pounds

growth rates. Since the industry is mature, the plastic resin industry was greatly affected by the depression in the global economy in the early 1990s. Plant closures and capacity cutbacks were partly successful in preventing further price declines during this period (Department of Commerce, 1994). From 1993 to 1998, global consumption of plastic resins has increased approximately 4 percent annually.

Global Economy

As the global economy rebounds from the recession of the early 1990s, growth is expected to be stimulated by upswings in the packaging, building, and construction markets. This growth is expected to occur primarily in countries along the Pacific Rim and in Latin America as these countries continue rapid industrialization, increased consumer spending and substitution of other materials by plastics. Plastic resin production capacity is also increasing in these regions in response to the high demand.

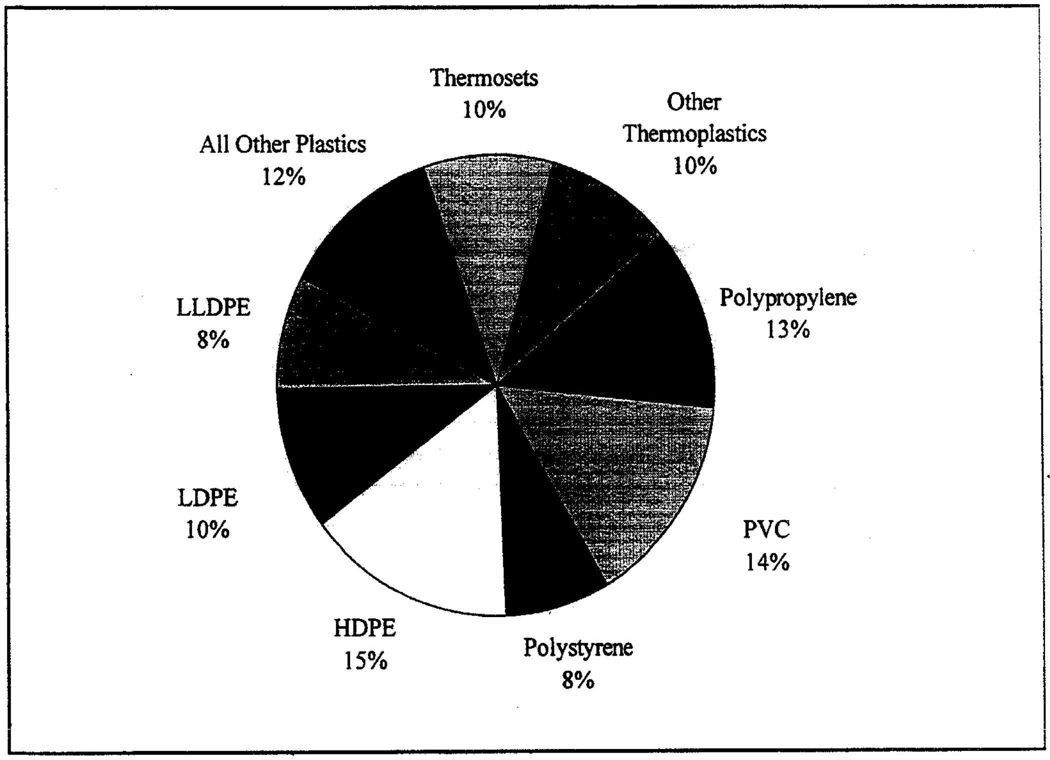
United States Market

The U.S. represents the largest single plastics market in the world, based on factors such as large domestic markets, readily available capital and technology, and relatively inexpensive raw materials and energy costs. In the U.S., consumption and production are not experiencing high growth rates. This is, in part, due to the high level of substitution of traditional materials (like wood or metal) for plastics currently in place and the fact that the commodity plastics market is well-developed. As a result, major plastic resin manufacturers are merging and swapping production lines. Large multinational chemical companies are arranging licensing agreements as a way to tap into foreign markets. The plastic resin industry is also focusing on upgrading its production to higher-value-added and specialty resins tailored for niche markets. Research on plastic resins has started to focus on refining existing resins through blends and alloys and also improving catalyst technology to produce new grades of polymers. For instance, several companies are planning to produce specialty grades of polypropylene using new metallocene catalysts (McGraw-Hill, 1994).

Industry Advancement

Advances in plastic resin properties is expected to spur growth and foster the development of new end-use markets. For instance, the cost, low weight, and versatility advantages of new plastic resins will make them more attractive in the auto assembly industries. Environmental regulations and concerns have an impact on many facets of the plastic resin industry. The demand for recycled and biodegradable plastic resins is expected to continue and drive development of more economical recycling technologies (Department of Commerce, 1994).

Distribution Percentages



Source: SPI Committee on Resin Statistics as compiled by Association Services Group, LLC, 1995.

Figure 200.5: Percentage Distribution of Plastic Resins: Sales and Captive Use, 1994

203.2 MANMADE FIBER INDUSTRY

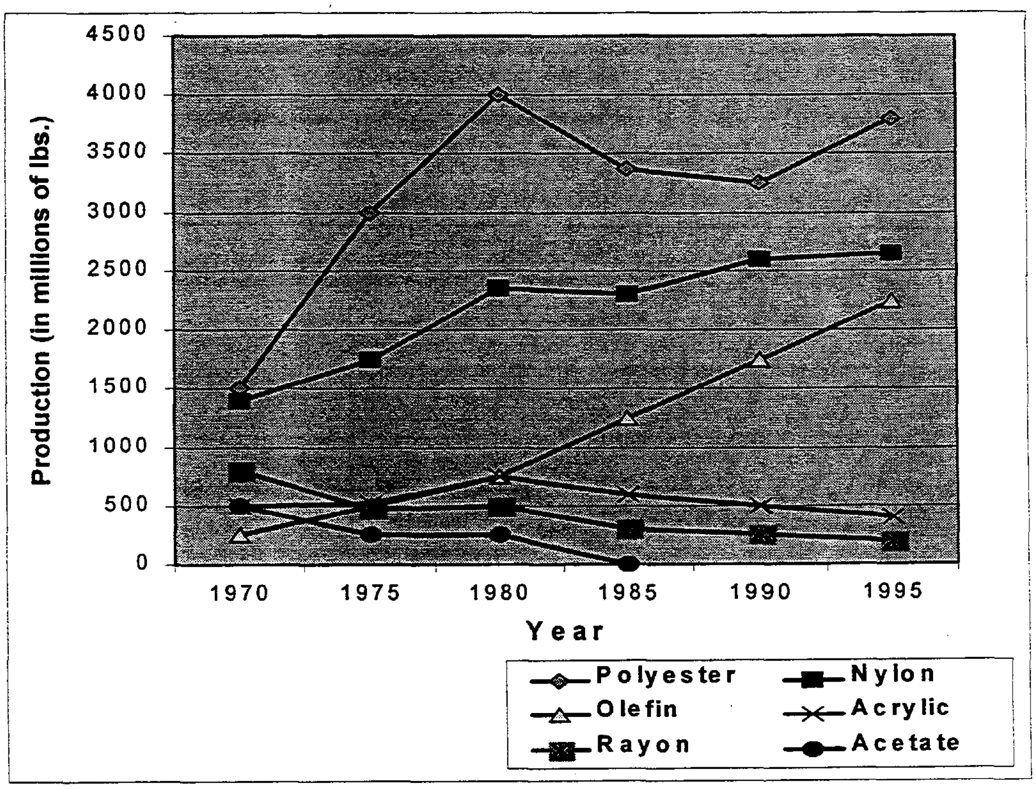
Synthetic Fibers

One-half of all fibers consumed are manmade. In 1992, global demand for manmade fibers increased by 3 percent. In the past, developed countries have dominated the manmade fiber industry. Between 1980 and 1993, the developing countries of Asia led by China, Taiwan, and Korea have accounted for most of the growth in manmade fiber production. During that period, these countries increased their aggregate share of world production from 15 to 42 percent. Developing countries are expected to continue increasing production and capability as their consumption and demand levels increase.

On the other hand, production in the U.S. has remained relatively stagnant. Figure 200.6 shows U.S. production trends from 1970 to 1995 for selected cellulosic and noncellulosic fibers. Figure 200.6 shows that production of polyester and nylon fibers was significantly greater than the production of cellulosic fibers, such as acetate and rayon. Note that numbers for acetate production and rayon yard production were not available for 1985 to the present since the industries have shrunk to only a few companies. As a result, data do not appear for acetate from 1985 to 1995, and data for rayon represent rayon yarn and staple production for the period from 1970 to 1980 and rayon staple production only from 1985 to 1995.

U.S. Production

In 1993, U.S. manmade fiber imports rose 11 percent due to increases in noncellulosic fiber imports. U.S. exports decreased 1 percent in 1993. Meanwhile, domestic shipments of noncellulosic fibers, such as nylon and polyester, increased by 2 percent. U.S. shipments of cellulosic fibers increased 14 percent to $1.8 billion primarily due to growth in rayon staple fiber demand and production. Rayon production has undergone extensive renovation to achieve additional environmental benefits and become more competitive with noncellulosic fibers (U.S. Department of Commerce, 1994).



Source: Fiber Economics Bureau, Inc., 1996.

Figure 200.6: Manmade Fiber Production Data for Selected Fibers 1970-1995

Manmade Fiber Industry Growth

Barriers to entry into the manmade fiber industry are considerable, since production is highly capital intensive and requires significant technical expertise and economies of scale. Since the mid-1980s, the manmade fiber industry has undergone extensive consolidation and reorganization. During 1989-1993, several fiber companies sold off smaller fiber operations, which produced higher value-added products. In addition, large companies, which traditionally produce commodity fibers, have looked to the sale of specialty fibers (e.g., heat-resistant or high-strength fibers) as a way to increase overall profits (Department of Commerce, 1994). Back-integration of the carpet industry has resulted in the establishment of many new, small fiber producers (AFMA, 1997).

Because the manmade fiber industry is highly developed, the industry's most promising growth is expected to occur through these improvements in fiber characteristics. For instance, the *U.S. Industrial Outlook* states that microfiber yarns and fabrics have enabled manmade fibers to compete more directly with luxury fibers, such as silk and cashmere, in fashion apparel. The industry also predicts that lyocel, a new fiber which can be produced with particular environmental benefits, will contribute to cellulosic fiber growth (Department of Commerce, 1994). In addition, the industrial and technical products market is expected to continue to be dominated by manmade fibers (AFMA, 1997).

300 PROCESS & CONTROL

Raw Materials Inputs

Raw material inputs to plastic resin and manmade fibers industries primarily consist of synthetic organic chemicals, such as ethylene glycol and acrylonitrile, and refined petroleum products, such as ethylene. The majority of these chemicals are used either as monomers or as monomer precursors. Other uses are as solvents, catalysts, and additives. Because chemical processes rarely convert 100 percent of raw materials to desired products, byproducts and unreacted monomer may constitute a large part of facilities' wastestreams. Pollutant outputs generally include VOCs, off-spec or contaminated polymer, and wastewater from equipment cleaning. Typical wastestreams associated with processes involved in plastic resin and manmade fiber manufacture are listed in Table 300.1. Wastestreams vary depending on what polymer is being synthesized, what fiber spinning method is used, and whether a batch or continuous process is used. Small-scale batch facilities that make polymers to order often have complex and variable wastestreams (New Jersey Hazardous Waste Facilities Siting Commission, 1987).

Mold Process

Companies using polyester resin materials are formulating products from a mold process, where a mold is prepared of the final outside shape of the product. A mold release agent (usually a pastewax) is applied to enable the part to be separated from the mold at a later point in the process. After 24 hours, a gel coat is added over the mold release agent and it is allowed to cure such that it no longer flows. The next step involves the application of the resin, either by hand lay-up or by spraying through a chopper gun. Air bubbles are removed by application of pressure from rollers, brushes, and daubers, or by a vacuum applied to the mold.

Plugs

Successive layers of resin and fiberglass are applied until the necessary thickness is obtained. The molded product, called the "plug," is separated from the mold and strengthening forms are added inside the plug to protect against collapse. Additional layers of resin fiberglass can be added at this point if needed. The mold release agent is removed and minor surface imperfections are filled in. Painting of the product can now occur if needed. Colorants can be added to the resin fiberglass process to negate painting if the manufacturer wishes to do so.

301 TYPES OF OPERATIONS

Operations

The following is a brief discussion of individual modes of operation common to fiberglass operations. Control of VOCs will also be addressed in this chapter.

300 PROCESS & CONTROL

Table 300.1: Summary of Potential Releases Emitted During Plastic Resin and Manmade Fiber Manufacturing

Process	Air Emissions	Process Wastewater	Residual Wastes
Preparing Reactants	volatized monomer, solvents	little or no wastewater produced	raw material, drum residuals
Polymerization	volatized monomer, solvents, reaction byproducts	little or no wastewater produced	off-specification or contaminated polymer, reaction byproducts, spent equipment oil, spent solvent, catalyst manufacture waste, gas purification catalyst waste
Polymer Recovery	volatized solvents and unreacted monomer	little or no wastewater produced	little or no residual waste produced
Polymer Extrusion	volatized solvents and unreacted monomer	extruder quench water	off-specification or contaminated polymer
Equipment Cleaning	volatized solvents and unreacted monomer	reactor and floor wash water contaminated with organics, acids, and salts; equipment rinse water	little or no residual waste produced
Unloading and Storage of Reactants	volatized monomer and solvents	rinse water from cleaning out transport vehicles containing solvents, monomers, and other reactants	little or no residual waste produced
Conveyance and Pellet Storage	volatized residual monomer or solvents from plastic pellets	little or no wastewater produced	plastic pellets from leaks or spills
Spinning	volatized residual monomer solvents, additives, other organics, volatized finishes	water contaminated with residual monomer solvents, additives, other organics, finishes	off-spec polymer, off-spec fiber, and residual finishes
Fiber Processing	volatized residual monomer solvents, additives, other organics, volatized finishes	water contaminated with residual monomer, solvents, additives, other organics	residual monomer and solvents; off-spec fibers
Pollution Control Systems	volatized solvents and unreacted monomer	water contaminated with residual solvents and unreacted monomer; air stripper water	little or no residual waste produced

Source: U.S. EPA, *AP-42*, Office of Air & Radiation, 1993; U.S. EPA, *Best Management Practices f/Pollution Prevention in the Textile Industry*, Office of R & D, 1995; *SOCMA Pollution Prevention Study*, Prepared f/SOCMA, Washington, D.C., 1993; Randall, P.M., "Pollution Prevention Strategies f/Minimizing of Industrial Wastes in the Vinyl Chloride Monomer - Polyvinyl Chloride Industry", in *Environmental Progress*, vol. 13, no. 4, November 1994; AFMA, 1997; Wellman, 1997.

301.1 HAND LAY-UP OPERATIONS

Lay-Up Forming Operations

The hand lay-up operation is the simplest type of forming operation. For many operations, hand lay-up is combined with spray-up applications, giving operations greater flexibility. A mold is prepared and the requisite mold release agent (either alcohol or pastewax) is applied to the surface of the mold. Gel coat is then added over the mold release agent. After the gel coat has cured, the hand application of chopped fiberglass strands can begin. Resin is then added via use of pressure fed hand rollers, brushes, or squeegees as described in Figures 300.1 and 300.2. This method produces a high strength-to-weight ratio product compared to products made via spray-up application. A large surface of resin is exposed to the atmosphere for a majority of the production cycle and creates high VOC (styrene) emissions.

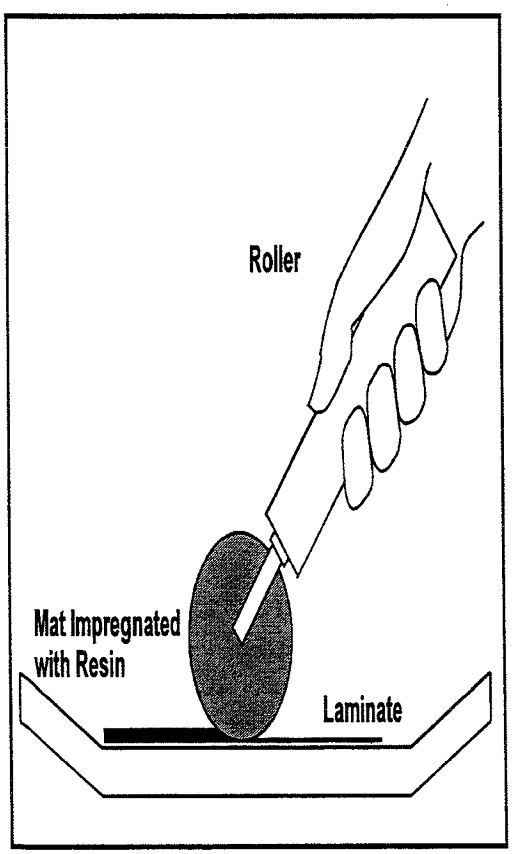


Figure 300.1: Hand Lay-Up

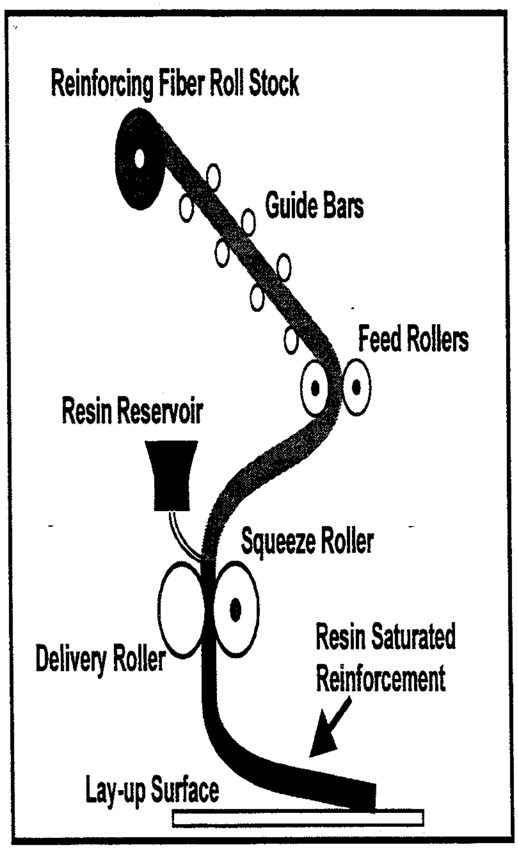


Figure 300.2: Lay-Up Surface

300 PROCESS & CONTROL

Resin Roller Dispensing Units

Roller dispensing of resin is receiving a considerable amount of attention as a possible method for reducing styrene emissions without requiring major modifications in molds and materials. Like spraying systems, resin roller dispenser units, also called detail rollers, utilize a fluid pumping system to draw resins from drums or bulk distribution lines. This pumping system also includes a separate, fully adjustable catalyst pump. These two pumps supply the resin and catalyst to a static mixer. Since atomization is not required, resin delivery pressures are well below 100 psi. Pressures are normally regulated for the purpose of controlling the rate of resin delivery. Catalyst flow rates are precisely tied to resin flow to insure a high level of control over catalyst-to-resin ratios and cure rates. Delivery rates for catalyzed resins may be as high as 20 pounds per minute.

A flexible material hose is attached to the mixer and carries the catalyzed resin to the roller applicator. Units can be mounted to wall fixtures or portable carts. However, a more effective method is to mount the static mixing unit on an overhead traveler that looks like a lightweight gantry crane. This arrangement gives the operator complete freedom of movement without having to hold or drag a hose around the work area. This set-up also reduces the volume of catalyzed resin and reduces the chance of resin gelling in the wand and roller. The roller handles are normally adjustable in length to allow for a variety of working requirements. As the operator rolls out the reinforcing materials, he or she can control the flow of resin as needed through a trigger mechanism.

The resin flow is distributed by a manifold within the roller. A typical roller cover is about 9" wide by 1 1/2" in diameter and has about 150 holes that are about 1/32" in diameter. This arrangement distributes the resin uniformly around the circumference of the roller. In operation the roller is in continuous use throughout the shift so the catalyzed resin is always being flushed through the roller cover until it is discarded at the conclusion of the shift. After the roller cover is discarded, the mixing unit, hose assembly, wand, and roller manifold are flushed using a small amount of solvent re-circulated in a closed system. Another advantage inherent in the roller system is the combining of tasks - the operator does not need to change tools as often when switching from resin application to roll out operations. An example of a roller system is illustrated in Figure 300.2.

301.1.1 Prepreg Fiber

Prepreg Fiber

For a number of years fabricators of composite aircraft structures have relied on the use of fiber reinforcements that are presaturated with resins. These materials, referred to as "prepreg," offer a number of advantages over conventional spray techniques. Resin to fiber ratios can be closely controlled; atomization of pollutants is practically eliminated; and clean-up and disposal problems are greatly reduced. These advantages are, however, not enough to make prepregs widely accepted by most fiberglass fabricators.

Prepregs are generally formulated with more expensive epoxy based resins which require placing the mold in an oven or autoclave to complete the cure cycle. These more expensive resins are normally combined with exotic, high strength reinforcing materials, such as graphite fibers. Storage is also a problem since the materials must remain refrigerated until the lay-up process is started. Prepregs appear to be best suited for applications where extremely high strength-to-weight ratios are required and cost factors are secondary.

301.1.2 In-House Resin Impregnation

Impregnators

Equipment is now available to provide the fabricator with some of the advantages offered by epoxy prepregs while using lower cost polyester resins and fiberglass materials. Impregnators can be placed within the lamination area of a plant and mounted in such a manner as to feed resin saturated reinforcing materials directly to the molding operation. A static mixer can be incorporated with conventional resin pumps and a catalyst metering device to provide the proper mix to a roller-reservoir system. Woven fiberglass is impregnated as it passes through this reservoir system.

Impregnators can be designed to fit a variety of potential applications. The units can be mounted to lift systems, over conveyor fed lines, on bridge cranes, or on portable carts. Conventional resins and roll fiber materials are used. Machine size and capacity can be engineered to provide a variety of output feed rates and to accommodate a number of roll widths. Units currently available can produce as much as 20 linear feet per minute with resin-to-glass ratios controllable to within +/-2 percent. Larger units have an output capacity which can exceed 1,000 pounds of laminate per hour with a 50 percent glass content.

300 PROCESS & CONTROL

Impregnators

Impregnators would appear to have considerable potential for the reduction of pollution associated with open molding operations. Delivery of the resin to the reinforcing laminate by means of an impregnator would help insure that a cleaner, safer, and more comfortable work area would be maintained. Since there would be no spray atomization of resins, the levels of in-plant and external emissions would be minimized. At the same time, requirements for high levels of make-up air and elaborate air handling systems would be minimized.

Quality and productivity may be improved through the use of resin impregnation systems. High volume delivery rates can speed lay-up of large components and lead to the development of an assembly line approach to molding smaller components. Impregnators insure a high degree of control of fiber-to-resin ratios and catalyst-to-resin ratios. Worker productivity may also be expected to improve because strenuous rolling operations are reduced and air within the working environment will be less contaminated from styrene.

Plant Modification

For many fabricators, installation of impregnator systems may require extensive modification in the plant layout and production techniques. The units are more expensive than existing spray applicators, but their per unit output can be considerably higher. Use of impregnators by builders of small boats would appear to be economically feasible only if the facility could be arranged so that the molds are handled in an assembly line manner, or situated so that one machine could be easily positioned to feed a number of molds. Impregnators merit attention from any company planning new facilities or changes to existing facilities. Builders of larger components, such as large boat hulls or tanks, may be able to use impregnators with little change in plant facilities. Maintenance and repair requirements would appear to differ little from the requirements of conventional spray systems. The potential for savings is greatest where operations demand the production of large volumes of resin saturated roll stock. Small volume producers are not likely to find great use for currently available systems. Payback potential lies in five areas:

1. Increased output of saturated laminates;
2. More efficient use of materials;
3. Improvement of existing processing strategies;
4. Improvement of laminate quality; and,
5. Reduction of the need for elaborate air filtration and other pollution control systems.

301.2 SPRAY-UP OPERATIONS

Spray-Up Operations

Spray-up operations account for a large portion of the industry. As in hand lay-up operations the mold preparation is accomplished first. Mold release agent is applied next and allowed to set for a period of time (usually overnight). Fiberglass roving and resin are applied to the mold surface with a "chopper gun" which chops the fiberglass roving into one inch lengths and simultaneously sprays a predetermined amount of resin and catalyst. The resin and catalyst can be mixed inside the gun (internal mix) or can be mixed outside the gun as they exit (external mix). Since the resin is atomized in the spray-up process, it represents the highest potential for VOC emissions because the spray atomization creates an enormous surface area of exposed resin (see Figures 300.3, 300.4).

HVLP Spray Guns

CFA/NMMA

Transfer-efficient spray guns are used in this process to attempt to minimize overspray emissions; airless; air-assisted airless; high volume, low pressure (HVLP); and electrostatic spray guns are used in most districts. Additional information from industry (CFA-Composites Fabrication Association and NMMA-National Marine Manufacturing Association), shows that providing an external flange on the outside edge of the mold can reduce overspray. Touch-up and repair activities that occur in the final stages are exempted from the transfer-

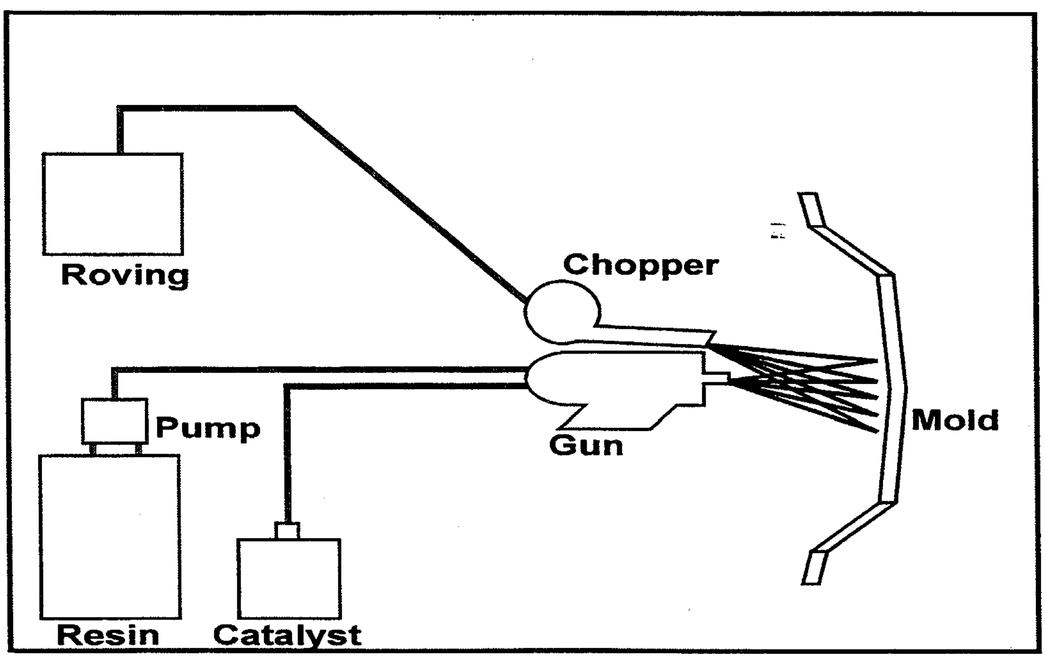


Figure 300.3: Spray-Up

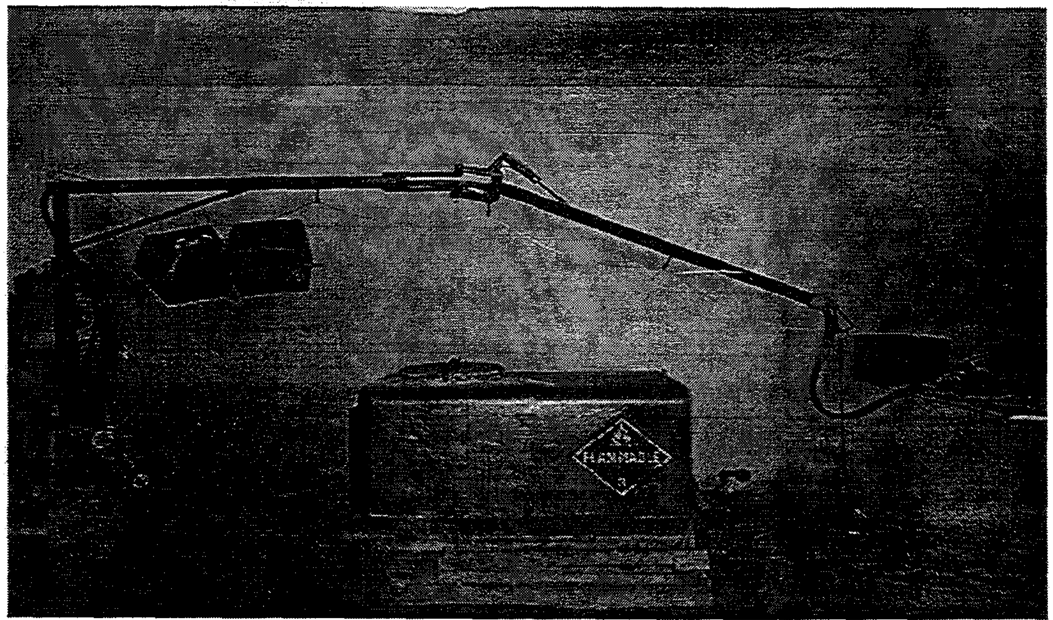


Figure 300.4: Chopper Gun Set-Up

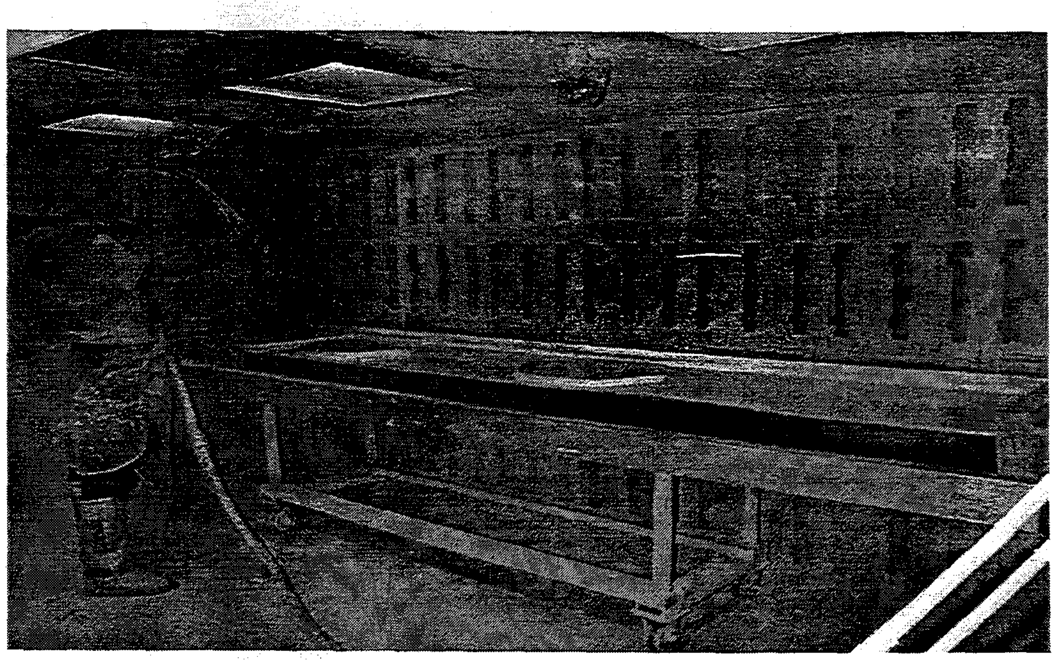


Figure 300.5: Spray Booth Operation

efficiency requirements, allowing an air atomization spray gun as long as the resin is applied from a small container attached to the spray gun and **not** from a fluid line attached to a remote reservoir.

301.2.1 Controlled Spraying

Controlled Spraying

Controlled spraying is a work practice that can be effective in reducing styrene emissions from the open molding process. It is an emissions source reduction method, which benefits the manufacturing process, plant personnel, the environment and reduces cost. Controlled spraying reduces styrene emissions by increasing material transfer efficiency through overspray minimization. Overspray has been found to be a major factor in styrene emissions. Transfer efficiency is the amount of material sprayed, compared to the amount retained on a mold surface. Controlled spraying is accomplished by minimizing spray gun atomization pressure and reducing overspray loss (see Figure 300.5). There are three elements of controlled spraying, which work together to reduce emissions:

* Operation of the spray gun at the lowest functional fluid tip pressure, which produces an acceptable spray pattern;
* Operator training that teaches proper spray gun handling techniques; and,
* The use of close contaminant mold flanges to minimize spray off the mold edge.

301.2.2 Operator Training

Operator Training

Spray gun operator training is an important aspect of a controlled spraying program. It is important that spray applicators and production management know how to properly set-up a spray gun, and understand the proper methods of spray gun handling. The practical application of controlled spraying is based on training that specifies how these methods work, and provides methods for verifying the effectiveness of the techniques.

301.2.3 Where Should Controlled Spraying Be Used?

Controlled Spraying Useage

Controlled spraying should be used for all spray applications of styrene based resins. This includes polyester resins, vinyl ester resins, polyester gel coats, vinyl ester gel coats and other resins containing a volatile monomer. Controlled spraying is beneficial in all composites manufacturing processes, where materials are applied by atomized spray.

This work practice technique should be used as the standard manufacturing practice in open molding facilities, or in other cases, where atomized spraying is used.

Styrene Emissions Reduction

Controlled spraying can provide a substantial reduction in styrene emissions compared to typical uncontrolled spraying. Testing has demonstrated that controlled spraying can reduce gel coating emissions by up to 40 percent, and laminating resin emissions by up to 20 percent (SCAQMD). Controlled spraying is a method of reducing styrene emissions that is universal for atomized spray application and provides benefits in a number of important areas.

There are a number of possibilities for styrene emissions reduction in the open molding process. These include the use of low styrene content resin or gel coat; the use of styrene suppressants; non-spray applications such as flow coaters or pressure rollers; and controlled spraying. Low styrene resins and styrene suppressants may not be suitable for all circumstances. Likewise, non-spray application is not currently feasible with gel coat, and may not be suitable for all circumstances. Controlled spraying, on the other hand, can be used in all circumstances where atomized spray application is required.

The emissions reduction, available from controlled spraying, is a win-win situation in all ways when it is achieved. The total quantity of styrene released to the environment, and required to be reported, will be reduced with the implementation of controlled spraying. Worker exposure to styrene will be reduced, and plant heating and ventilation flows may be able to be adjusted accordingly. Finally, the increased transfer efficiency offered by controlled spraying reduces material loss during the process. This has a positive impact on costs, in terms of quantities of materials consumed. Additionally, the reduction of overspray contributes to cleaner work areas, improved plant safety and overall housekeeping efforts.

301.2.4 Emissions During the Molding Process

Molding Process Emissions

When using atomized spraying, approximately half of the total styrene emissions produced from the open molding process takes place during the spray phase of the process. In the case of gel coating, 50 percent of the emissions occur during spraying and 50 percent during the curing process. With laminating resin spray application, about 55 percent of the emissions occur during spraying, 25 percent during the laminate roll-out phase, and 20 percent during the curing phase. The emissions from the spraying phase are a significant contributor to the total emissions.

Spray Gun Pressure

Fluid stream atomization contributes to emissions during the spraying process. The greater the level of atomization (creating finer aerosol particle sizes) and the higher the fluid stream pressure, the more emissions will occur. Because a large portion of emissions occurs during the spray phase of application, spray gun pressure is of primary importance. The lowest pressure that produces an adequate spray pattern will produce the lowest emissions.

301.2.5 Relationship Between Overspray and Emissions

Overspraying & Emissions

Another aspect of emissions involves the wet surface area of resin or gel coat. Once the material has covered the surface of the mold and surrounding area, emissions are a function of surface area evaporation. Therefore, the larger the surface area, the greater the evaporative loss. Since styrene evaporates from the surface only, the thickness of the laminate of gel coat film is not an issue once the material is in the static state on the surface. In this condition, the amounts of styrene lost from the surface of a thin film of overspray, and a thick laminate, may be almost the same. Therefore, reducing the surface area of overspray is a critical aspect of reducing surface area loss.

For example, a mold has dimensions of 4 ft. X 8 ft. (or 32 ft2) plus a 6 in. perimeter flange. Emissions = 8 grams per ft2 during curing phase based on surface area calculations.

301.2.6 Atomization

Spray Patterns

In order to create a useful spray pattern, it is necessary to convert a pressurized stream of resin into an elliptical shape as it exits the spray gun fluid tip. This elliptical fluid stream is known as a fan pattern or spray pattern. Atomizing the fluid is to break the fluid stream into fine aerosol particle sizes, which converts the narrow high velocity fluid stream into a lower velocity shaped spray pattern. In many cases the spray pattern also provides the means for external mixing of an initiator (catalyst) component with the resin stream.

Atomization Level

In order to achieve an acceptable fan pattern, a particular level of atomization is required. The required level of atomization will vary and is dictated by the characteristics of the rheology of the resin, resin temperature, spray gun type, required spray gun distance from the mold, and mold configuration. There is, however, an ideal minimum level of atomization for each combination of factors.

Atomization

Any additional atomization beyond that required level to form an adequate fan pattern, should be considered excessive. Over-atomization results in an increase in emissions from increased monomer evaporation and decreased transfer efficiency associated with enlarging the "wet footprint" of overspray.

The objective of minimizing atomization is to insure that atomization greater than required to produce an adequate fan pattern does not take place. This is accomplished by operating a spray gun at the lowest possible pressure at, which it develops a proper fan pattern.

301.2.7 Overspray

Overspray

Overspray is considered to be that resin which is deposited off the mold surface during the spraying process. This directly relates to transfer efficiency, which is the amount of material dispensed by the spray gun, compared to the amount deposited and retained on the mold.

Overspray has the effect of increasing the resin surface area by creating an enlarged "wet footprint," greater than the actual mold surface area. This increase in surface area contributes to an increase in emissions.

301.2.8 Types of Spray Guns

Spray Guns

There are a number of types of spray guns which may be used for gel coat or resin application. The general categories of spray equipment include:

* Conventional Air-Atomized;
* Spray Guns:
  - Siphon Cup Gun;
  - Gravity Feed Gun;
  - Pressure Pot Gun;
* High Pressure Airless Guns;
* Air-Assist Airless Guns; and,
* High Volume Low Pressure (HVLP) Guns.

301.2.9 Conventional Air Atomized Spray Gun Configurations

Air Atomized Spray Guns

With an air-atomized spray gun, the resin is delivered to the spray tip at low liquid pressure. As the low pressure fluid exits the spray nozzle, relatively high pressure atomizing air is forced across the liquid stream causing it to form a fan pattern. A siphon cup gun draws liquids up the siphon tube using the venturi effect. The material is then pulled along with the atomizing air at the spray tip. The gravity feed gun has a material cup mounted on top of the spray gun. The liquid flows down into the gun head and is mixed with atomizing air at the spray tip. A pressure pot gun uses a pressurized container (pot) to force the fluid flow to the gun head. The fluid then exits the spray tip in a straight stream, which is then formed into a fan pattern by the atomizing air.

Air Atomized Spray Guns

Air atomized spray guns are generally not used for production resin or gel coating application for several reasons. First, the flow rates produced by this type of gun are lower than required for most production applications. Second, air atomized spray guns produce the highest rate of emissions of all spray guns. The transfer efficiency (which is the amount of material sprayed compared to the amount which is retained on the mold) of air atomized spray equipment is very low. Because of this, material waste and emissions are higher than with other types of spray equipment.

301.2.10 High-Pressure Airless Spray Guns

High-Pressure Airless Spray Guns

Airless spray guns use a pump to deliver the resin coat to the fluid tip at high pressure. As the high-pressure stream exits the small fluid tip, the sudden reduction in pressure causes the fluid to atomize into a spray pattern. Developed in the 1960's, airless spray improves the transfer efficiency over the older air atomized application equipment. Airless spray tips usually require a fluid pressure of at least 1000 psi to produce an adequate fan pattern.

301.2.11 Air-Assisted Airless Spray Guns

Air-Assisted Airless Spray Guns

These current technology spray guns are a combination of airless and air atomized guns, drawing the benefits of both types. Air-assisted airless guns use a pump to deliver the resin to the fluid tip, but with much less pressure than an airless gun. The partially shaped fan pattern is then fully formed with the introduction of "shaping" air with the air-assist. The combination allows for reduced liquid pressure operation with control over the fan pattern shape. Air-assisted airless guns produce higher transfer efficiency than airless guns with reduced emissions. The lower pressure spray also enhances gel coat quality.

301.2.12 High Volume Low Pressure (HVLP) Spray Guns

HVLP Spray Guns

HVLP spray guns have been used in the spray painting industry for some time. While similar to the air-assisted airless guns in many ways, these units operate with air atomizing pressures of 10 psi or less. The low air pressure is replaced with a high volume of airflow, which results in reduced emissions, and better transfer efficiency.

301.2.13 Fluid Pumps

Air Over Fluid Pump

The most common type of resin pump is termed an air over fluid pump. An air driven piston drives a fluid piston, which forces the gel coat out to the spray gun at high pressure. The difference between the diameter of the air piston and the fluid piston is termed the pump ratio. Pump ratios usually range from about 11:1 up to 33:1. By multiplying the air-input pressure by the pump ratio the fluid pressure at the spray tip can be determined.

Example:

* Pump Ratio = 15:1 (15 psi of fluid pressure for every 1 psi of air pressure);
* Pump air pressure set at 40 psi; and,
* Multiply: Pump Ratio x Pump Pressure Setting to determine the fluid pressure.
* Fluid Pressure = 600 psi.

301.2.14 Flow Rate

Flow Rates

Flow rate is the amount of material sprayed in a given period. The flow rate is controlled by the size of the spray tip, pump pressure and resin viscosity.

The spray tip orifice size is generally dictated by the required flow rate for the particular size and configuration of mold to be sprayed.

Large parts, requiring large amounts of resin, are usually sprayed with larger size tips. Smaller parts or parts that are more detailed are easier to spray with smaller size tips.

The viscosity or thickness of the gel coat will affect both the flow rate and fan pattern.

Viscosity

Viscosity is normally adjusted by the gel coat manufacturer, but is affected by temperature. A cooler material will be thicker and will reduce the flow rate. While a warmer gel coat is lower in viscosity it flows at a higher rate.

301.2.15 Determining the Proper Spray Gun Pressure

Spray Gun Pressure

Determining the ideal pump pressure for a specific combination of material and equipment is an important element of controlled spraying. The goal is to apply resin or gel coat at the lowest level of atomization, which produces a workable spray pattern.

Sometimes operators feel they have to turn up the pressure to get an adequate flow rate. The proper method is to maintain minimum pressure and to increase the size of the spray tip to match the required delivery rate.

It is always an advantage to spray at the lowest possible pressure. The lowest pressure will:

* Reduce Styrene Emissions;
* Minimize Overspray;
* Create better working conditions;
* Enhance catalyst mixing;
* Reduce material usage;
* Reduce equipment wear;
* Reduce high pressure hazards;
* Reduce static charge build-up; and,
* Increase product quality.

301.2.16 Composites Fabricators Association (CFA) Pressure Calibration Procedures

CFA Pressure Calibration Procedures

The proper spray gun pressure calibration procedure is very straightforward and is appropriate for all production spray guns.

* Verify that the resin is the correct temperature, and has been properly mixed within the manufacturer's specified period.
* Verify that the spray tip is in good condition and suitable in flow rate range and fan pattern width for the given job.

Pressure Calibration Procedures

* Aim the spray gun at a disposable surface on the floor, maintaining a distance of 12" to 18" and perpendicular to the floor.
* Turn the pump pressure down to zero and pull the trigger.
* Slowly begin to increase the pressure in 10 psi increments until the fan pattern meets requirements.
* Record this pressure in the spray gun set-up log.
* Do not increase the pressure past this point. The result will be over-atomization and increased overspray, and poor transfer efficiency.

301.2.17 Determining the Proper Spray Pattern

Spray Patterns

The size of a spray pattern results from a unique combination of orifice size, tip angle and resin flow characteristics. The required fan pattern width is specific to the size and configuration of the part being sprayed. The size of the spray pattern should match the spraying requirements. For example, a large flat part requires a wide fan pattern. A small part or one with a complex shape may require a narrow fan pattern.

There is, however, one trait all properly adjusted spray patterns have in common; a symmetrical shape where the material is distributed evenly across the length and width of the spray pattern.

Fan patterns develop from a round straight stream of resin at very low pressure to elongated, but irregular shapes as the pressure increases. As the pressure reaches the perfect point for that combination of factors, a symmetrical elliptical shaped spray pattern develops. If the pressure is increased past this point, the width of the pattern might increase slightly, but there will be no improvement in the symmetry.

301.2.18 Spraying Techniques

Spraying Techniques

Operator spraying technique is an essential factor in reducing emissions as well as producing a high quality work. There are basic elements of spraying technique which contribute to effective application of resin or gel coat. Where you aim the spray gun is important. The object of controlled spraying is to minimize overspray. Always attempt to hold the gun perpendicular to the surface. As the spray gun assumes a lower angle in relation to the surface, overspray will increase. Spray on the perimeter of the mold first, while maintaining overspray within the boundary of the closed containment flange. When spraying the interior of the mold, work out to the material previously applied to the perimeter and stop short of going off the mold edge.

Spraying Techniques

Always begin by spraying the section nearest you. The reason for this is to prevent a momentary off-ratio burst of material from spraying on the mold surface. By starting with the closest area of the mold and working outward, you will minimize the likelihood of raw catalyst falling on exposed mold surface and possibly damaging the mold.

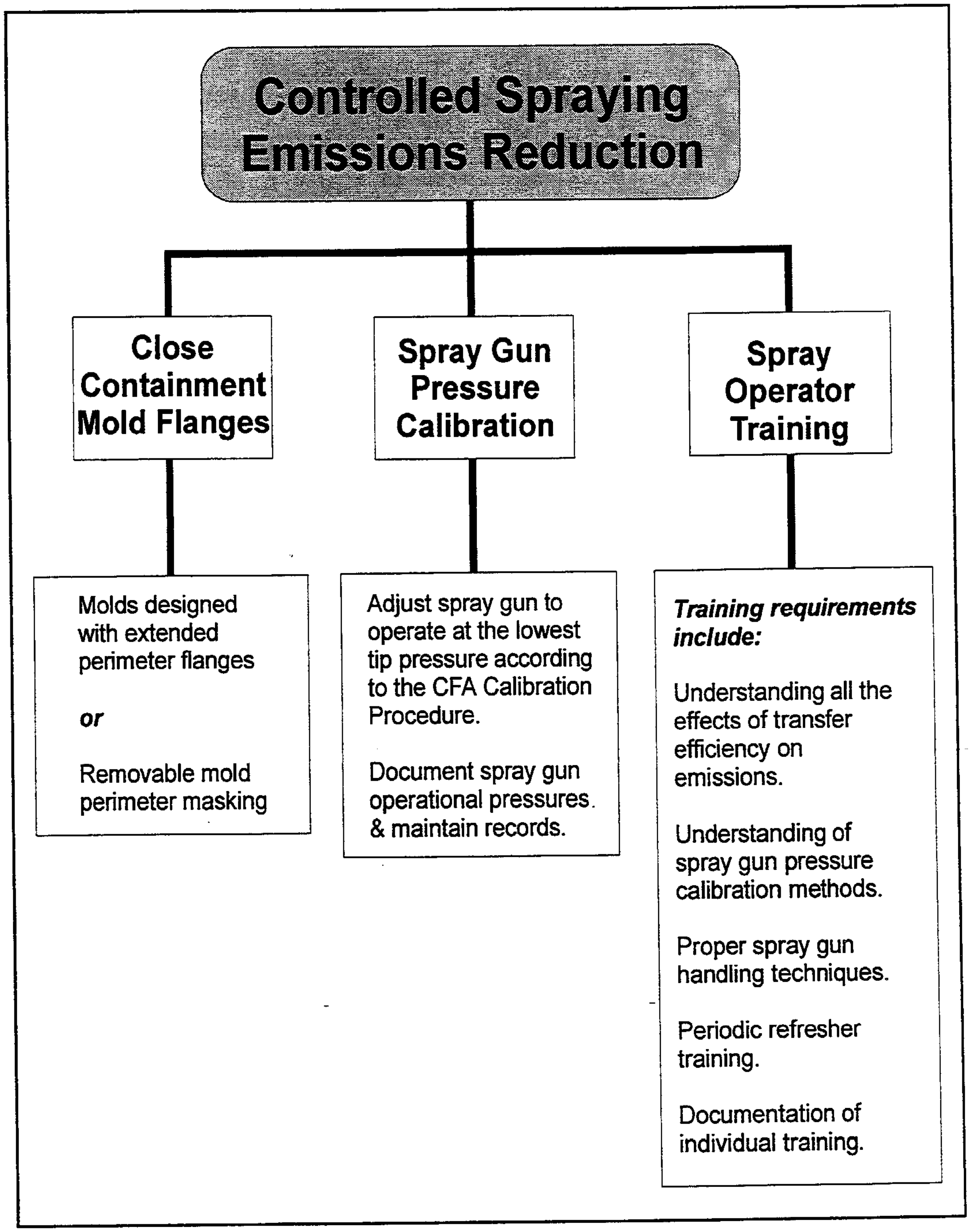
Avoid triggering the gel coat gun on and off as you would a paint spray gun. In addition, the trigger should be "full-on or full-off" to maintain the proper material ratio. Do not "throttle" the gun with a partially open trigger.

Always attempt to keep the fan pattern at right angles (perpendicular) to the mold surface and avoid an arching motion with the gun. Follow the contour of the mold as closely as possible. Avoid spraying at a low angle. It will be difficult to control overspray and the material thickness will taper off further away from the gun. In the case of an arching spray movement, the change in spray angle at the end of the stroke will make overspray difficult to control.

Do not assume you can apply the proper thickness by feel or experience. There are a number of variables, such as tip size and condition, pump pressure, viscosity and temperature that can affect the delivery rate. Because of this it is essential for even experienced operators to mil gauge every part.

Applying the right film thickness is a function of time and motion. The spray gun puts out a specific amount of material in a given amount of time. The number of passes needed to be made will be determined by the gun operator based on individual product requirements. How much material applied to an area is a matter of how fast the gun covers an area. The operator must concentrate on maintaining a constant speed throughout the application. It is best to spray an area about as large as a comfortable arm swing. Avoid pivoting the gun with the wrist and do not bounce the spray pattern. The proper technique is to use smooth long strokes, while keeping track of spray bands.

For more information on current studies comparing different spray guns and how they effect emissions, you may contact either Geddes Ramsey at (919) 541-7963, or Carlos Nunez at (919) 541-1156 at the U.S. EPA.



Source: Pacific Northwest Pollution Prevention Resource Center

Figure 300.6: Controlled Spraying Emissions Reduction

Controlled Spraying

Controlled spraying is one of those rare situations in FRP/C production where there is no downside. All of the effects of this technique are beneficial. In addition, controlled spraying is "do-able" in every plant at little cost. You need to make controlled spraying the standard in your plant, to prepare for the demands of tighter regulation and to upgrade your production process. Additional techniques involving non-spray methods are also on the horizon.

301.3 CONTINUOUS LAMINATION

Laminating Techniques

A continuous strand of fiberglass roving is chopped and evenly distributed onto a continuously moving sheet of cellophane or some other type of non-adhering plastic sheeting material (see Figure 300.7). The chopped glass layer (from the roving strands) is then saturated with precatalyzed resin and immediately covered with a second sheet of cellophane. The glass/resin composite sandwiched between the cellophane sheets is then pulled through a forming die and passed through a curing oven. The cured panel is then stripped of its cellophane covering, trimmed along the edges, and cut to the desired length. VOC emissions are minimized by the top and bottom cellophane sheets.

301.4 PULTRUSION OPERATIONS

Pultrusion Process

A pultrusion operation consists of a pulled extrusion process where roving strands of fiberglass are pulled through a strand tension device and immediately immersed in a resin bath or are wetted out through resin injection. As they exit the resin bath, the joint glass/resin composite strands are pulled through a forming die and then through a heated die where they are cured (seen in Figure 300.8). Flat stock of varying widths can be cut to length and packaged. VOC emissions occur primarily at the open resin bath and forming area and are a function of exposed open area, line speed, styrene concentration, and ambient temperature. VOC emissions from curing are minimal since this is a closed operation.

301.5 FILAMENT WINDING OPERATIONS

Filament Winding Operations

Filament winding operations have become quite popular for manufacturing large pipes, storage tanks, and other hollow vessels that may be subject to great internal pressure. Continuous strand rovings are pulled by a rotating mandrel through a strand tensioning device into a resin bath. After emerging from the resin bath, the strands, each uniformly coated, are wound onto a mandrel to the shape and pattern required for the finished product. The wound product is then cured in an oven or at room temperature, depending on product requirements. VOC emissions are moderate due to a product requirement for low resin viscosity which can lead to high monomer (styrene) concentrations (see Figure 300.9). Sometimes additional resin is sprayed or flow coated on.

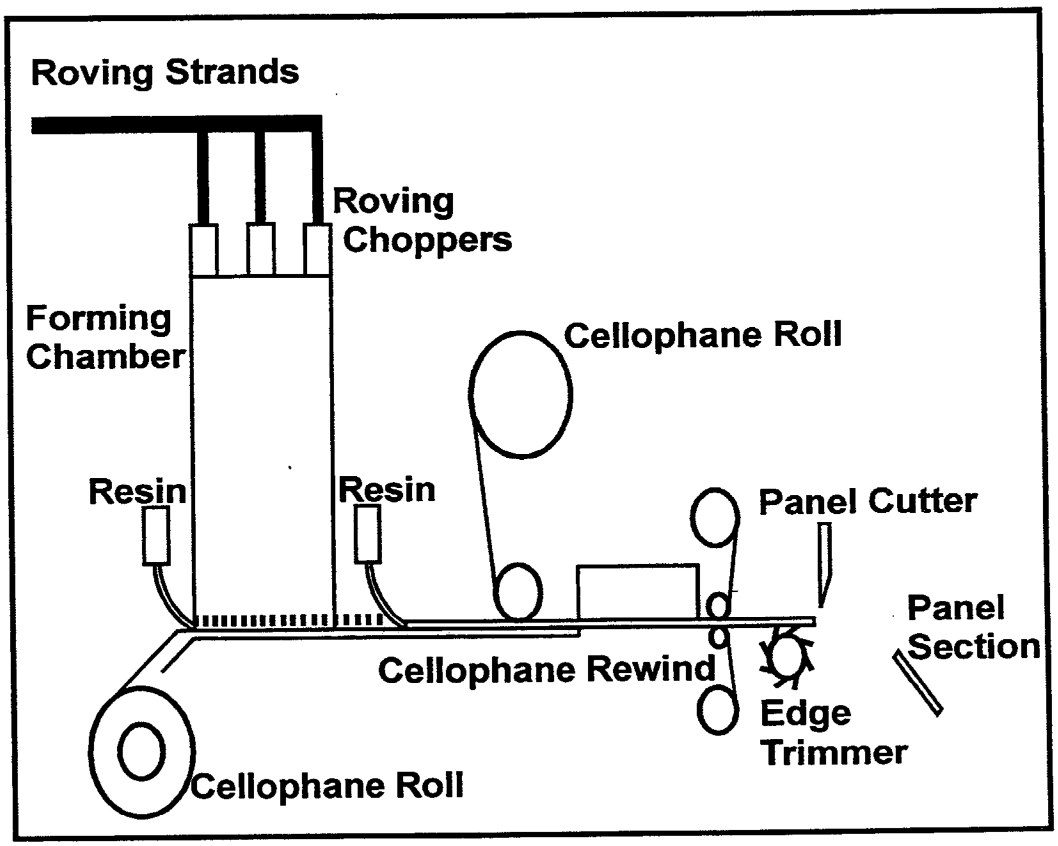


Figure 300.7: Continuous Lamination

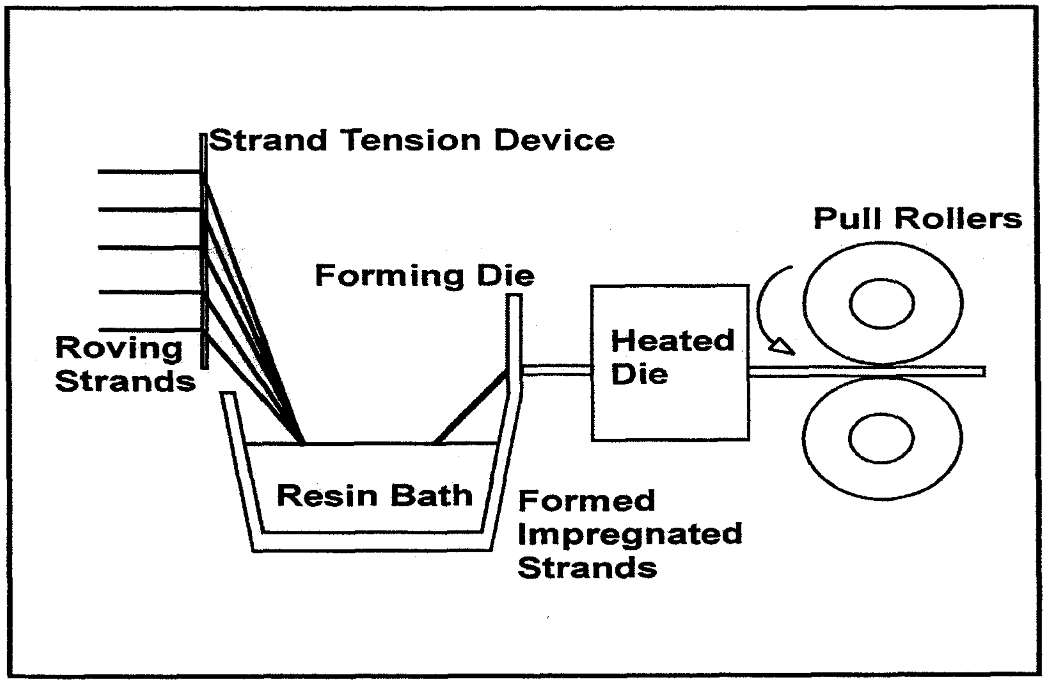


Figure 300.8: Pultrusion

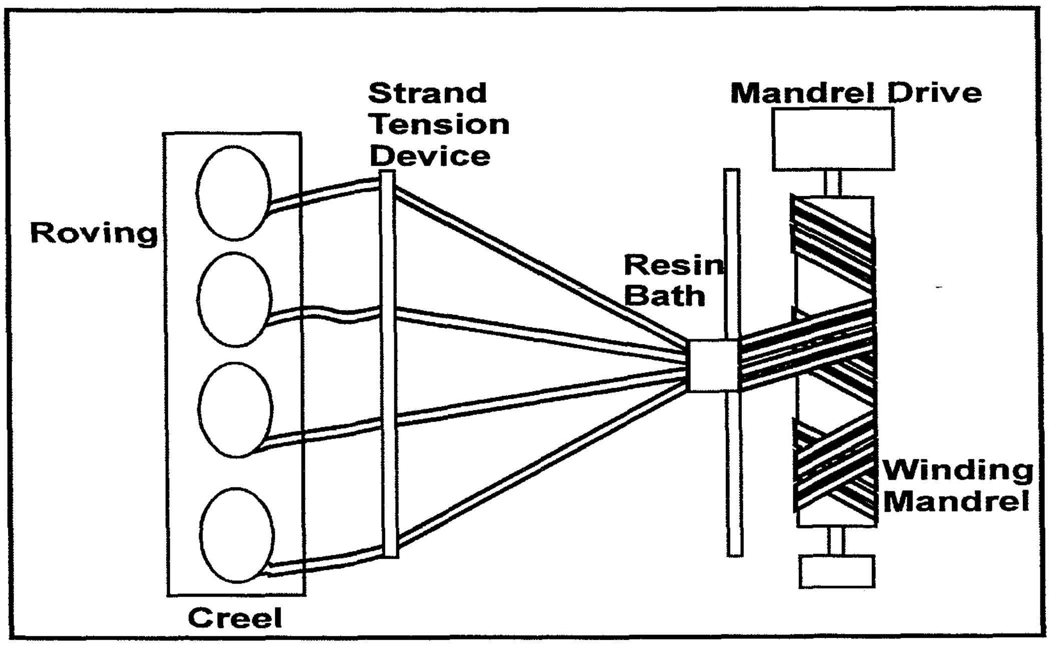


Figure 300.9: Filament Winding

301.6 CASTING OR MOLDING OPERATIONS

Molding/ Casting Processes

BMC/SMC Processes

Casting or molding operations are used when manufacturers want a finished product with one or two open smooth surfaces. Continuous strands are laid by hand into a mold and catalyzed polyester resin is poured or injected into the mold cavity. In certain operations the resin is mixed with fiberglass and other inert fillers to form a putty or dough-like resin, commonly called bulk molding compound (BMC) or sheet molding compound (SMC) process. These processes can be used for very complex shapes and for core materials that require added structural strength. The majority or these processes are closed mold processes. VOC emissions are generally low because the primary VOC emitting process is enclosed inside the mold, as illustrated in Figure 300.10.

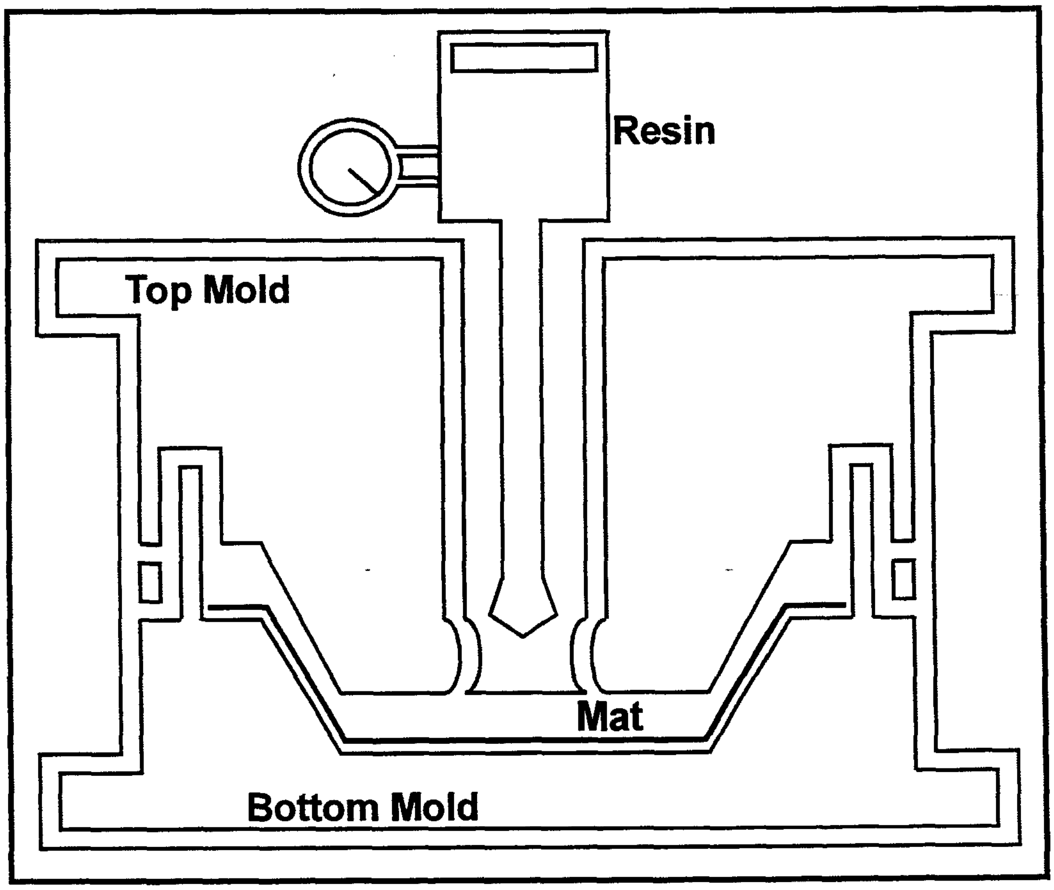


Figure 300.10: Resin Transfer Molding

RTM/SMC/BMC Processes

Use of a closed-mold process is an excellent way to reduce styrene emissions. Some of these processes are the Resin-Transfer Molding (RTM) process, the Sheet-Molding Compound (SMC) process, and the Bulk-Molding Compound (BMC) process.

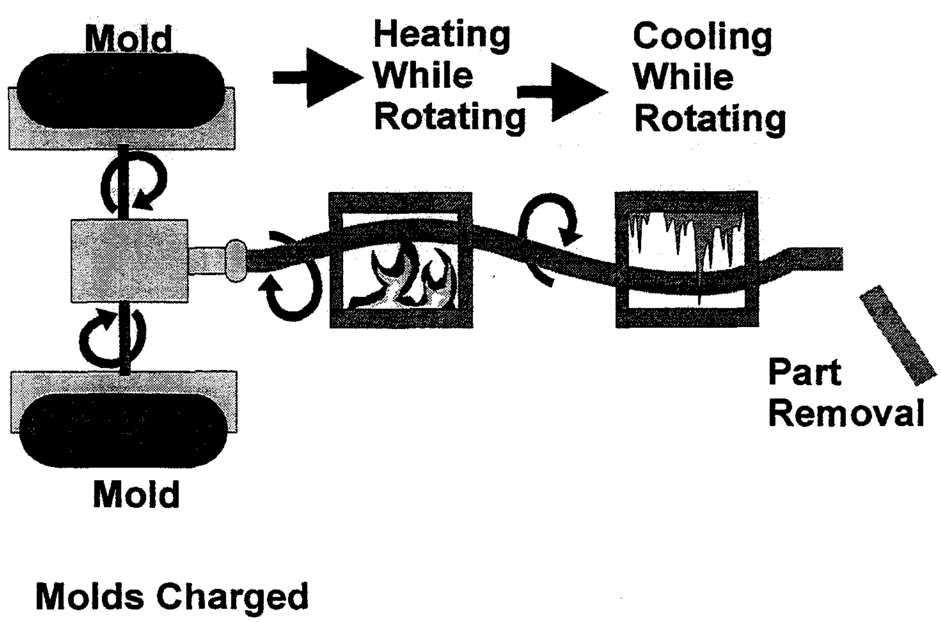


Figure 300.11: Rotational Molding

301.7 ROTATIONAL MOLDING

Rotational Molding Process

Rotational molding is a manufacturing process that produces a rigid or semi-rigid hollow part by charging a hollow mold with a measured amount of powdered thermoplastic resin. The process begins by charging a mold which is then rotated simultaneously around two perpendicular axes. While being rotated, the mold is subjected to a two phase cycle. During the heating phase the mold is brought to the resin melt point and held at that temperature to melt the resin and coat the interior of the mold. Next the mold rotation is continued through a controlled cooling cycle. After cooling, the mold halves are opened and the part is removed. Cycle times may be as low as five minutes for small products. Times for larger products with thick walls will be considerably longer. Figure 300.11 depicts the basic rotational molding process.

Rotational Molding Processes

Rotational molding provides an attractive alternative to in-plant production of open molded assemblies. Tooling costs for molds are considered to be compatible with tooling costs for conventional molds. Rotation molds for the tanks are produced from inexpensive aluminum castings. Because open molding fabrication and curing cycles are lengthy, a number of conventional molds are required to insure adequate daily output of tanks. Only one rotational mold is required to maintain production. Several companies have replaced fiberglass tanks with thermoplastic tanks using this process. Indications are that the thermoplastic units meet design and performance requirements for strength and durability. Per unit costs are compatible with open molding on low volume runs and less expensive per unit on high volume runs.

Open Molding

Changing from in-plant open molding to rotational molding requires careful study and planning. Changing processes are best done when product redesigns and/or new product designs create a need for new tooling and molds. Chemical and physical properties of thermoplastic tanks are significantly different than those of fiberglass tanks. For this reason basic tank designs will need to be altered along with assembly and installation techniques.

Rotational molding is not an answer for all producers of open molded components. The process is best suited to items which are hollow in structure and require uniform wall thickness. Items which are open, relatively shallow in profile, or require inserts and internal structural features are difficult to produce through rotational molding. Replacing in-plant open molding with in-plant rotational molding requires major investments in ovens, materials handling equipment, and specialized processing equipment. Strength and durability properties of many of the plastic materials used for rotational molding may not match properties of materials used in open molding.

301.7.1 Combining Subassemblies to Minimize Waste

Waste Reduction in the Composites Industry

An effective strategy for waste reduction in the composites industry is combining two different functional components into one, thus eliminating the source of one waste stream. A good example of this approach is a patent pending process for boat hulls developed by Structural Composites in West Melbourne, Florida. Structural Composites has created a means to combine flotation foam with a tailored hull conforming box mold to fit the hull stringer system. The product called the PRISMA Composite Preform System replaces the traditional wood stringers that manufacturers glass into the hull of motor boats. Typically, these wood stringers serve to stiffen the hull and provide mounting points for tanks, engines, and flooring in the boat. The Composite Preform System provides a dry fiber-reinforced outer surface that is cased to shape using a two-part self-rising non-CFC urethane foam core. The composite preforms are custom manufactured, ready for lamination and can be used in either an open or closed molding system.

Boat Hulls and Stringer Systems

To start the process, the boat builder has to provide Structural Composites with a boat hull and stringer system (loose). Once received, the first step is to create a set of box molds that accurately conform to the hull, stiffening grid, and the location points for mounting components in the boat. The size of the box molds must also be designed to provide the proper buoyancy for the boat. Once the molds are built, Structural Composites is ready to begin production of the replacement stringer system. The original hull and stringer system are returned along with the first preformed system for the boat builder's approval.

The production sequence for the stringer system is as follows. First, a custom stitch-bonded glass fabric is laid out on all sides of the box mold. Next a polyester fabric (Trevira) is placed over the layers of glass. This provides a liner of material to which the foam can adhere. Once the box is fully lined, it is closed and clamped in preparation for the foaming operation. The hose delivering the foam is attached, and the foam is injected into the box molds as depicted in Figure 300.12.

The heat and pressure developed by the foam that could distort or mar the boat hull is easily handled by the mold. Once the foam is cured, the mold is opened and the glass encased foam stringer is removed. A stringer system is actually a set of interlocking components. Each component is molded separately and placed in separate plastic sheaths for shipment to the boat builder. Once the

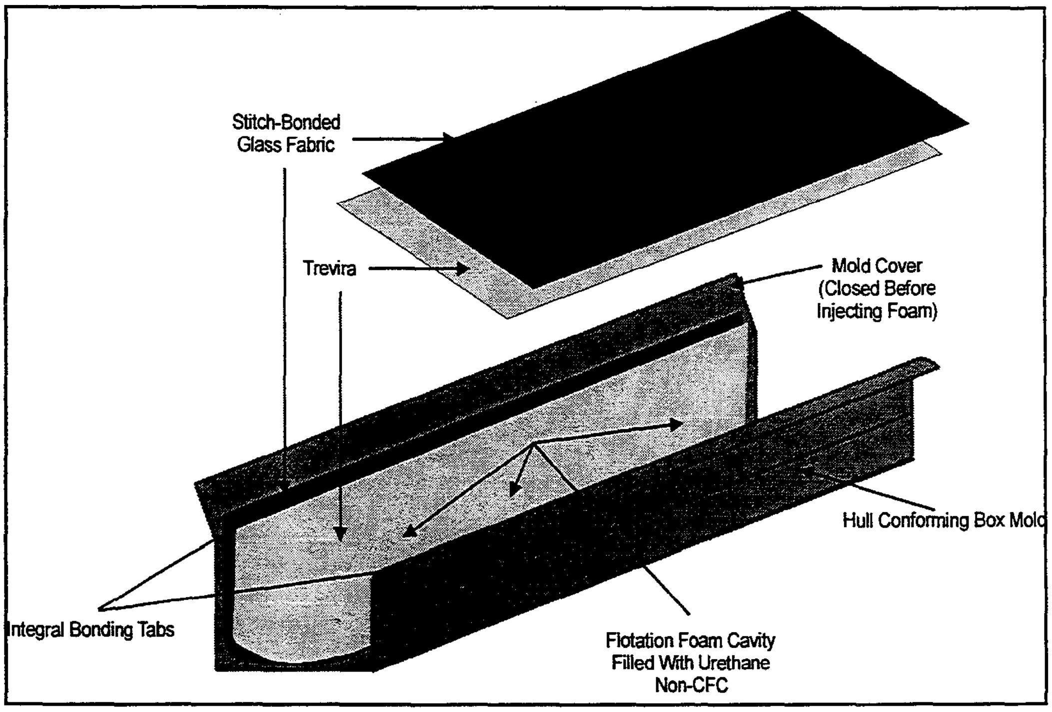


Figure 300.12: Integral Stringer and Flotation System

Stringer/ Flotation Systems

foamed core stringer system has been received by the builder, it is ready to be wetted-out with resin and attached to the hull. One of the unique aspects of the system is the extra glass that is provided for attachment to the hull. There is no need to tape the stringer since the glass extends 4" - 5" from the stringer. Indentations and channels to locate and hold other components are all molded in as part of the process to facilitate the building process.

Fabricators can simplify their construction process substantially by adopting this system. The stringer system provides boat builders with a well engineered flotation and reinforcing system that speeds the installation of interior components. The system also provides a reinforcing system that spreads loads out over wide areas of the hull and can substantially improve hull stiffness. The uniformity of the flotation system and its placement also provides the builder with predictable results. Supplemental blocks can also be provided to precisely fit in areas under a deck to provide needed stability.

To determine if this approach for creating a molded stringer/flotation system for your boats is profitable, you will have to carry out a comprehensive review of your manufacturing costs. In general, builders of high performance boats ascribe the following benefits of this system:

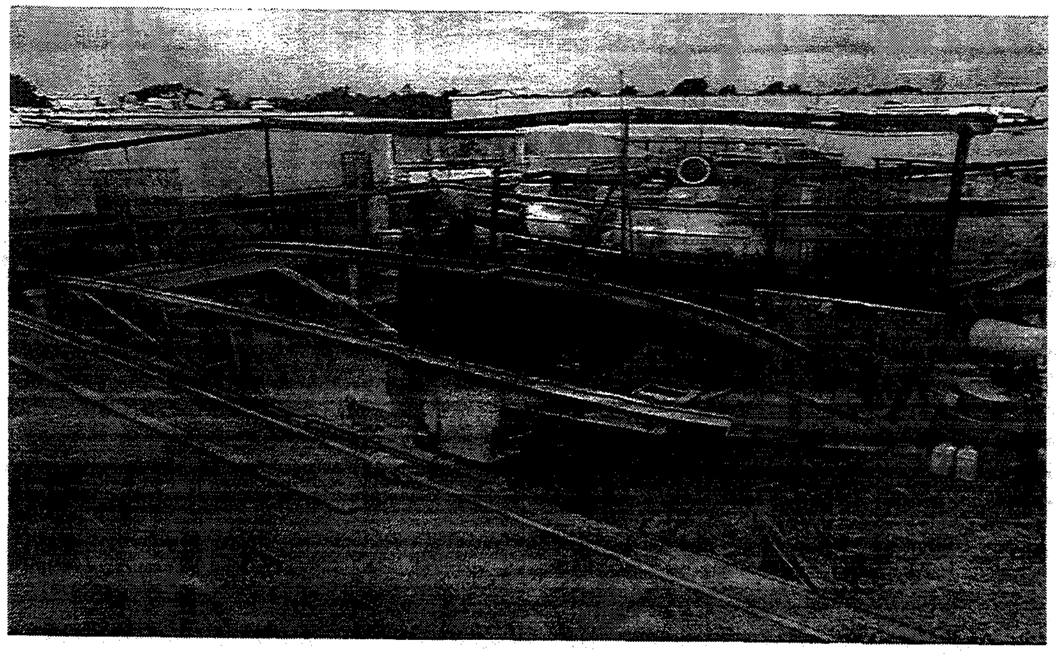


Figure 300.13: High Performance Boat Open Mold System

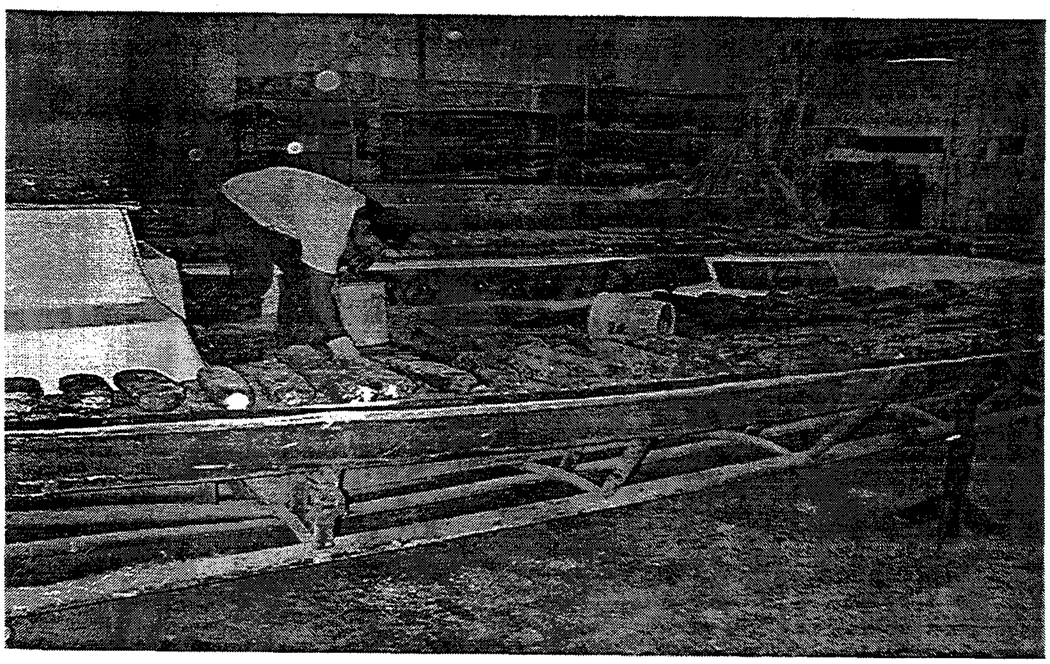


Figure 300.14: Closed Mold Process for Yacht Manufacturing

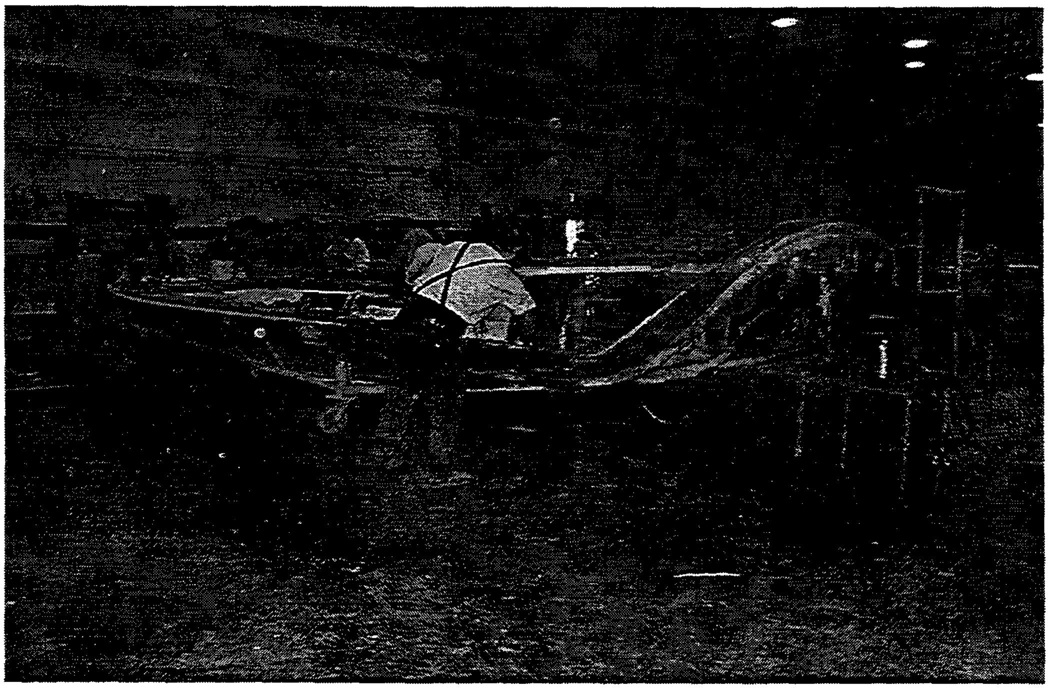


Figure 300.15: Bulk Molding Compound Closed Mold for Yachts

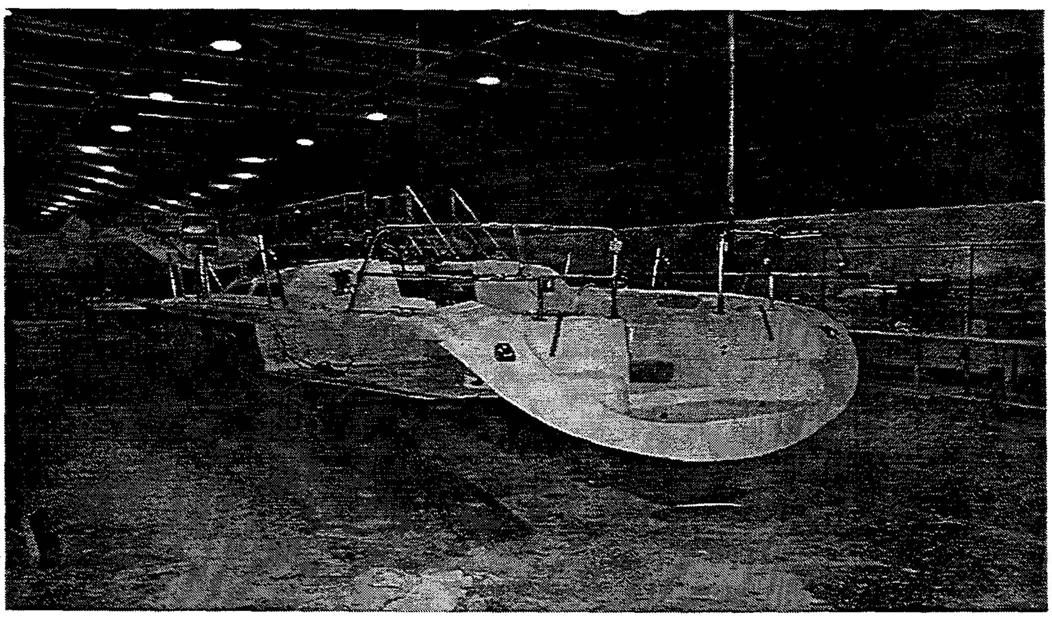


Figure 300.16: Yacht Mold Curing

Hull Reinforcement System

* Provides a well engineered hull reinforcement system that is less labor intensive to install;
* Creates an integral flotation system;
* Eliminates the majority of foaming operations in the plant;
* The structural grid serves as an accurate jig to speed the mounting, locating, and attaching other interior components; and,
* Eliminates wood as a reinforcement material.

These advantages reduce labor costs and provide a means to substantially increase rate of production without increasing the number of hull molds or floor space required. The system also reduces scrap fiberglass.

301.8 RESIN TRANSFER MOLDING (RTM)

Resin Transfer Molding (RTM)

Fabricators who make fiberglass products can choose from a variety of production methods. Open molding spray-up and hand lay-up production techniques are frequently employed by smaller firms or those who produce limited numbers of units from each mold. Open molding carries a high per piece cost due to the labor intensive methods inherent in the process, limited daily output from each mold, and waste. Closed mold technologies may offer a practical alternative to reduce these costs if volume and part design are appropriate. Closed molding operations practically eliminate requirements for atomization of resins and may offer a number of production advantages over conventional approaches to molding. The closed molding technologies most frequently applied to production of fiberglass components are compression molding, resin transfer molding, SCRIMP, CCBM and other infusion molding.

Compression Molding

Compression molding can reduce high per unit cost, but only if production volume is high enough to sufficiently spread out the high cost of the matched metal dies. Special molding compounds of resin and reinforcing materials are normally required. The molding compounds are compressed between heated matched mold surfaces, as depicted in Figure 300.17.

Output is high because the molding compounds cure rapidly in the heated mold. Some materials yield a good finish without application of a gel coat. Both surfaces of the molded product will be as smooth as the mold. Compression molding processes have been used successfully in the automotive and personal water craft industry for more than 25 years. Production output requirements for this type of molding will need to approach 150 parts-per-mold-per-shift to provide a reasonable base to spread out the costs of molds and tooling.

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Resin Transfer Molding (RTM)

Another closed mold process known as resin transfer molding (RTM) has also been in use for several years. Like compression molding, RTM utilizes matched molds. However, the matched molds do not have to be made of metal, and high pressure mold closing systems are not required. RTM appears to offer many advantages to firms that seek production volumes of 500 to 10,000 parts per year.

RTM production systems can be set up to replace many conventional open molding processes. Molds can be produced from the same materials and with the same techniques required for production of conventional molds. The molding resins and filler materials differ little from materials used to produce similar components in open molds. Even the gel coat finishes are the same as those produced in open molding.

RTM is carried out in a closed mold at room temperature. Processing begins with the application of a gel coat to one or both sides of the mold, depending on requirements. Glass reinforcing and other materials, such as core stock, are placed in the bottom half of the mold. The mold halves are closed and securely clamped. After the mold is closed, catalyzed resin is injected through one or more strategically located ports. Inlet ports and vents are normally located in the top half of the mold.

Resin Injection Pressure

Resin injection pressures are typically between 30 and 75 psi. The matched molds are laid-up over a pattern in the same manner and with the same types of materials used to produce molds for open molding. Some specialized tooling is required to insure that alignment and damping pressure are maintained when the molds are closed. The molds must also be properly reinforced to avoid flexing during the injection and curing cycles. Inlet ports and vents must be properly located so that resin is pumped into all parts of the mold. Mold and tooling quality determine the quality of the part.

Pollution output is greatly reduced since application of the gel coat is the only step in RTM that requires atomization of resin. Pumping catalyzed resin into a closed mold virtually eliminates vapor emissions and odor by confining the resins in the mold until curing is complete. There is little, if any, waste of resin. Even dust producing secondary grinding operations are reduced because the closed molding system eliminates most flash removal and edge smoothing requirements.

Quality and productivity may be improved through the use of RTM. The molding system produces parts that can have an excellent finish on both sides. Open molding requires at least two molding operations and secondary assembly work to produce parts with two finished surfaces. Since conventional mold making practices can be employed, start-up and tooling can be accomplished quickly and economically once experience with this technology is gained. With complex parts, the lay-up of reinforcing materials, core stock, inserts, and resin can be accomplished in one step.

RTM Applications

Low molding pressures required for RTM help reduce many expenses associated with other molding approaches. Less energy is required to operate material delivery units. Lower operating pressures reduce the cost and maintenance of pressure lines and fittings. Wear on pumps, accessories and controls is also reduced. Routine clean-up of the working environment should be needed less frequently.

RTM applications seem best suited for intermediate volume production of small to midsize components. Large items, such as boat hulls, can be produced using RTM techniques, but tooling costs per unit would be quite high. Items such as restaurant seats, hatches, doors, recycling bins, automotive parts, tubs, and shower units are much better suited to this type of processing. Molds for products of this size can produce parts that require a minimum of trimming, assembly, and secondary finishing. Initial investments in RTM may be returned quickly if there is sufficient volume. In comparison to open molding, potential savings are greatest when production rates are moderately high and both sides of the component must be finished. In situations where product demands are high enough to require increases in productivity, RTM should be explored.

Questions that should be asked regarding production requirements are as follows:

* Is the part high volume?
* Need two good sides?
* Is wall thickness tolerance important?
* Are delivery dates critical?
* Need a way to reduce styrene levels?
* Is floor space limited for high volume production?
* Are size tolerances critical?

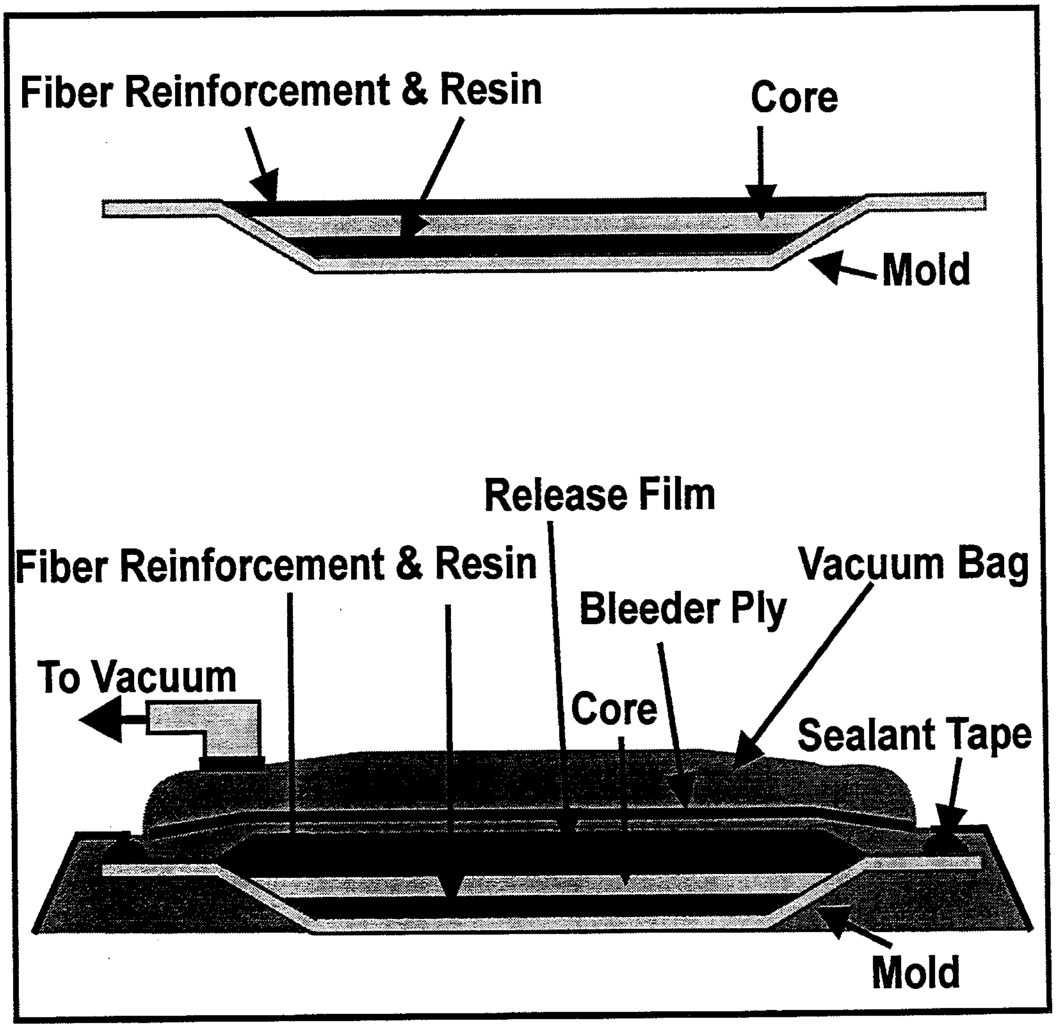


Figure 300.17: Compression (RTM) Molding

Questions that should be asked regarding secondary operations are as follows:

* Are size tolerances critical?
* Need good fit and match-up?
* Can you amortize tooling costs that may be more than ten times the price as the design constraints without any drawbacks?

Thermoplastics

The plastic industry as a whole uses far more thermoplastics than thermosetting plastics. Thermoplastics processing offers faster curing cycles, lower emissions during processing, lower costs per pound of raw material, ease of recycling and lower labor intensity. Advances in processing technologies and thermoplastic resin systems are causing many in the industry to examine alternative approaches to the molding process. New engineering grades of thermoplastics can be reinforced with fiberglass or other fibers. These materials can rival the strength of many of the strongest thermosets. Production machinery and tooling costs, however, are still high for thermoplastics forming processes such as injection molding extrusion, and blow molding. Often, thousands of parts must be produced in order to provide a reasonable amortization for mold costs alone (large chrome plated steel molds may cost more than $100,000 to produce a part with only a few square feet of surface area). Molds for processes such as rotational molding, however, can be produced at costs low enough to warrant the interest of some open molders.

Processing Technologies Advances

301.9 VACUUM BAG MOLDING PROCESSES

Vacuum Bag Molding Processes

Vacuum bag molding processes can be set up to replace many conventional open molding operations. Molds are built from the same materials using the same techniques required for creating open molds. Resins and filler materials differ little from those used to produce components in open molding. Conventional gel coating operations can also be utilized.

The vacuum bagging process begins with the application of a gel coat to the surface of the mold. When a high quality finish is desired, a surfacing layer of glass is carefully placed over the gel coat. Glass reinforcing and other materials, such as core stock, are cut to fit and placed in the mold. Catalyzed resin can be sprayed, pumped, or poured over the lay-up. Where multiple layers of reinforcing and/or core materials are used, the resin should be applied so that proper distribution to all parts of the lay-up can be assured. Once the lay-up materials are in place, the exposed area is covered by special layers of plastics which are sealed to the edges of the mold. Before the resin begins to cure, a vacuum is drawn through one or more strategically located ports in the mold or the plastic cover. A cross section of a vacuum bag molding set-up is pictured in Figure 300.18.

Vacuum Bag Lay-Up

A number of benefits can be derived through the use of vacuum bag lay-up. With the exception of the gel coat, resin delivery can be accomplished minimizing atomization. Labor involved in rolling out air bubbles and distributing the resin is reduced since the vacuum can be used to insure full distribution of resin to all parts of the lay-up. A high degree of control of resin-to-glass ratios can be maintained by carefully controlling the vacuum and by placing a release film (peel ply) and bleeder material between the laminate and the vacuum bag to absorb excess resin. Complicated lay-ups with reinforcing core stock can be accomplished in one operation instead of in steps that require curing before new layers are added. Product quality and strength are improved since the vacuum removes trapped air and serves as a damp to insure tight bonding of all materials in the lay-up. The release film, or ply, applied over the lay-up can be smooth or textured to produce a rough, smooth, or patterned surface.

Vacuum Requirements

Since vacuum requirements are typically low and curing takes place at ambient temperatures, molds can be made up of conventional tooling resins and reinforcements. Molds are laid-up over a pattern in the same manner as those used for open molding. Some specialized tooling may be required in the form of vacuum lines, fittings, and ports. A substantial vacuum pump and manifold system are also required.

When spray guns are not used to deliver resin to the mold, styrene emissions can be greatly reduced. Since final distribution of the resin to all areas of the lay-up is largely controlled by the vacuum, gel coating is the only step in vacuum bag molding that requires atomization of resin. Pumping or pouring premixed catalyst and resin into a closed mold eliminates fogging, bounce-back, and overspray. Vapor emissions and odor are further reduced by confining the resins in the covered mold until curing is complete. Excess resin can be trapped by bleeder material placed under the vacuum bag. Even dust producing secondary grinding operations are reduced because the closed molding system eliminates most flash removal and edge smoothing requirements.

Vacuum Bag Molding

Quality and productivity may be improved through the use of vacuum bag molding. The molding system produces parts with smooth surfaces and internal structures which are free of voids and excess resin. Open molding may require two or more operations to produce parts with high performance core stock, while vacuum bagging allows the lay-up to be accomplished in one operation. Start up and tooling can be accomplished quickly and economically. Direct lay-up labor costs may be reduced, and rate of production from a mold may be improved. Resins used in some vacuum bagging operations may have to be designed for the process. With large or complex structures, gel times will need to be extended, and thick lay-ups should use resin systems that will not produce excessive heat. When the application of material can be accomplished within a relatively short period of time, conventional resins may be used.

Vacuum bag molding is probably best suited for intermediate volume production of small to midsize components. Items such as large boat hulls and aircraft wing structures have been produced using vacuum bagging techniques, but large surface areas may be difficult to cover with lay-up materials before resins begin to gel. Products such as seats, boat hatches, boat deck structures, cored bulkheads, and other items with relatively shallow draft molds are ideal for this type of processing. The release film can also impart a fair finish on the second surface that may eliminate a need for secondary operations to improve the inside finish.

Vacuum Bagging Costs

Initial investments in vacuum bagging may be returned quickly in some applications. In comparison to open molding, potential payback is greatest where production rates are moderate, high strength and low weight are essential, and the shape of the product is not overly complex. Payback potential is limited when the mold design features deep drafts or complex shapes and demands of quality and strength are only average. A cost that must be considered is the extra solid waste that this method generates. Although some molders are able to reuse the fittings and even the bagging material, the bleeder material and the release film are all waste. The amount of cured resin that is thrown away in the bleeder material can be minimized by careful application of just the right amount of resin to the laminate. If this is not controlled, vacuum bagging can be an expensive source of solid waste. Since most fiberglass processors have limited financing for research and development of new production processes, vacuum bagging with good resin control is an attractive production alternative.

301.10 INFUSION OR SCRIMP PROCESS

Seemann Composite Resin Infusion Molding Process (SCRIMP)/Infusion

Infusion shares many of the characteristics of vacuum bag molding and resin transfer molding (RTM). Like RTM, infusion reduces styrene emissions by wetting out and curing the laminate in a closed system. The use of air pressure to squeeze the resin into the reinforcement fibers is a benefit that infusion has in common with the vacuum bagging process. One form of the infusion process, known as the SCRIMP (an acronym for Seemann Composite Resin Infusion Molding Process), provides many structural benefits that the developers of the process say rival the material and mechanical properties obtained in a highly controlled autoclave process. The infusion process creates a high performance laminate in one "shot," eliminating secondary bonding problems. The process also provides opportunities to achieve fiber to resin ratios as high as 70:30 along with the virtual elimination of air entrapment and voids. The key to the process is the resin distribution system patented by Seemann Composite Systems, Inc., which has several important technical features that enable a builder to get repeatable properties from a closed molding system suitable for low volume production. The process requires a mold similar to any open molding process and a unitary vacuum like the systems presented in Figure 300.18.

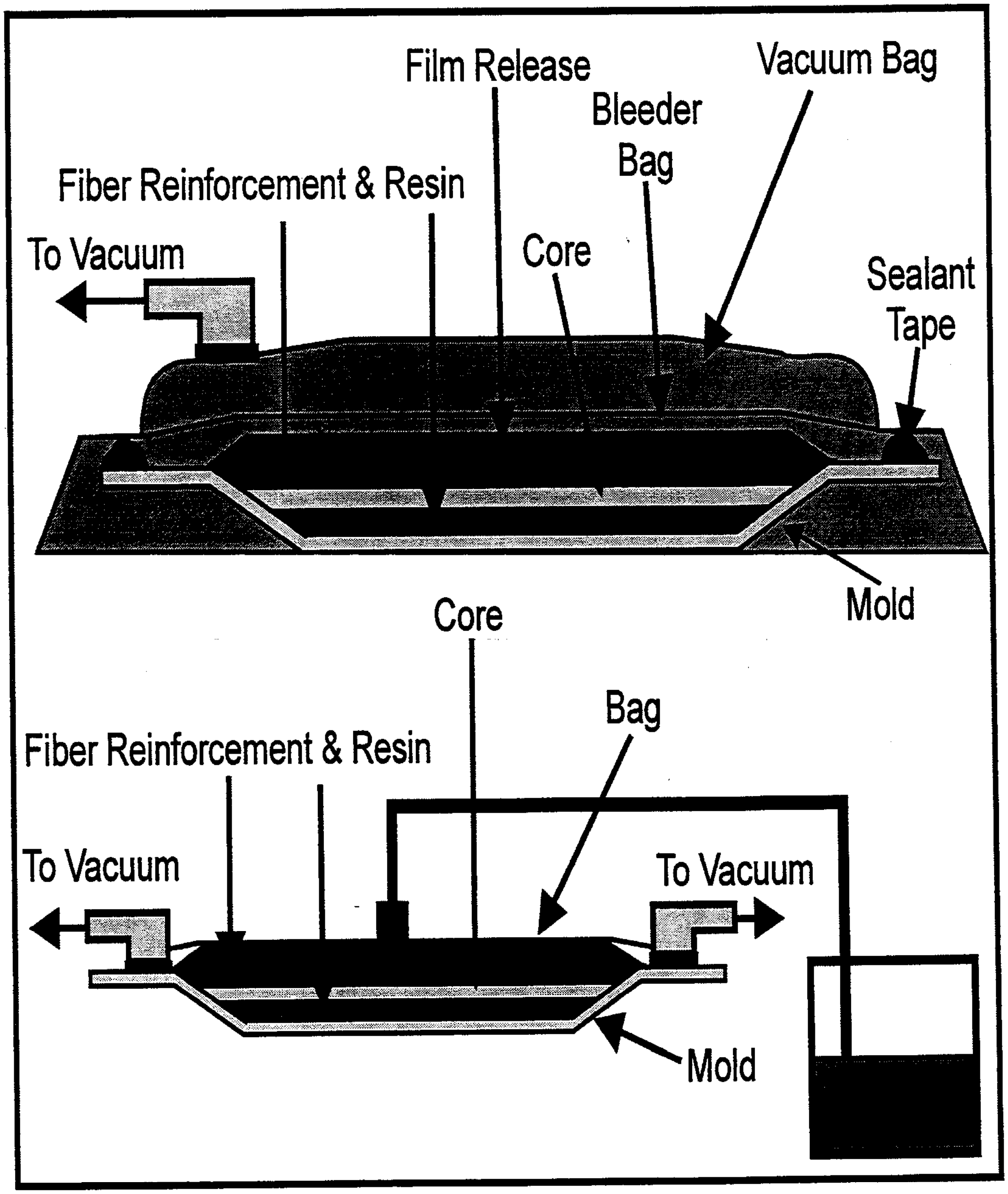


Figure 300.18: Comparison Vacuum Bagging and Infusion

Comparison Vacuum Bagging and Infusion Process

The process, as described in the patents, begins with the fabrication of a bag from silicone rubber to conform to the mold. The silicone rubber compound starts out as a brushable liquid. The bag is made up by applying several coats of silicone rubber over a completed lay-up that has been left in the mold. Once the silicone rubber is cured, it can be peeled from the mold providing a tough temperature resistant tailored form that can be reused many times. The bag or form also incorporates some other features such as open sided resin distribution ducts with branch conduits to provide paths to flow the resin to all parts of the laminate. At the periphery of the bag are vacuum conduits. Each of the major vacuum and resin conduits is provided with an inlet tube for connecting to a vacuum manifold lead or a resin supply tube. In addition, the bag can include a pattern of small pillars, cones, or pyramid shapes formed on the inner surface to hold the bag off the laminate. This provides local paths for the resin to flow to the laminate and covers most of the fiber lay-up expect for the perimeter where resin flow is directed into the fiber instead of across it. An alternative to this approach is the inclusion of a mesh or resin distribution media which serves to hold the bag off the laminate. Some of the current applications of this process use disposable bags which are used only once. This approach provides a significant amount of solid waste and is probably justified only for very low volume production. It is apparent that the reusable bag makes sense in terms of economics and waste reduction for sustained production.

Operation Sequence

The sequence of operation for the process begins with laying up the dry fiberglass against the mold in the desired amount and orientation. Coring material is also placed in a similar manner. Some builders use a spray adhesive compatible with the resin to hold the dry fiberglass in place. The vacuum bag with the resin distribution medium is put in place over the dry laminate. Once the system is sealed, a vacuum is then applied and the enclosed mold checked for leaks. After the system has been evacuated, the resin is introduced until runoff in the resin channels indicates that the laminate has been totally impregnated. The mold remains sealed until the resin is cured. After curing, the bag is carefully peeled away and cleaned for reuse.

Process Objective

The key objective in the infusion process is to create a conforming bag structure for a specific mold that can be reused without the necessity of laying-in individual distribution media, resin channels, and vacuum conduits each time a part is made in the mold. This reduces waste and minimizes the variability that occurs when a new resin and vacuum distribution system has to be constructed each time the mold is used.

Emissions Reduction

The reduction of styrene emissions has been widely reported as a major benefit from the infusion process. The infusion process provides additional benefits for companies producing highly engineered laminates that require excellent mechanical properties. Mechanical properties in terms of tensile, compressive, and bending strength from the infusion process are comparable to autoclave processing. Void content is virtually non-existent with this process.

To use the process laminators must acquire a license to use the patents and pay for training covering some proprietary techniques developed by TPI (formerly known as Tillotson-Pearson, Inc.) in Warren, Rhode Island. TPI has collaborated with Seemann Composites to commercialize the process. Each laminator will have to evaluate costs and benefits of the process to determine if this approach to composite construction is economically feasible for their circumstances.

301.10.1 Infusion With a Semi-Rigid Cover

Resin Infusion Recirculation Method (RIRM)

Structural Composites in Melbourne, Florida, has developed a molding process called the Resin Infusion Recirculation Method (RIRM). The process is similar to the vacuum bag infusion process, but with some significant differences. This molding process begins by placing dry reinforcement material in an open mold. Next, a semi-rigid cover containing ports for vacuum and resin connections is placed over the dry laminate and sealed around the edges of the mold. Once all the appropriate connections are made to the ports the infusion process begins. A vacuum is drawn on the mold to evacuate the air from the laminate. When this phase is complete, the resin is introduced. The supply tank for the resin has a slight over pressure (2-5 psig) which causes the semi-rigid cover to flex. This flexing opens a gap between the cover and the laminate. The gap provides a pathway for the resin to move across the laminate to insure its complete impregnation with resin. Once the laminate is completely wet-out, the resin inlet is closed and the atmospheric pressure squeezes the cover against the laminate as in the vacuum bag process. The semi-rigid cover, however, provides a smooth surface giving the completed part a second finished surface very similar to RTM.

The actual difference between vacuum bagging and this process is the use of a semi-rigid cover. This cover can be fabricated from a thermoplastic sheet and vacuum formed using the open mold with a finished laminate left in place. The vacuum formed cover should be transparent so that an operator can visually monitor the progress of the wet-out during infusion. The thickness of the cover is critical since it has to be able to flex at the interface between the resin and the dry laminate while still maintaining its basic form.

RIRM Process

The infusion process using a semi-rigid cover provides a closed molding system that will eliminate nearly all styrene emissions during the transfer of resin to the laminate. The process also reduces solid wastes since there is no overspray and limited trimming. A significant source of waste in most bagging processes is the disposal of the bag after molding. In this process the cover is not reusable.

The elimination of secondary bonding problems is a benefit with this process since the laminate is created in one "shot." The process also creates a second side that will have a good finish which in most cases will not require any secondary finishing operations. If the fabrication of the cover is carefully done, the process can furnish a high glass-to-resin ratio providing parts with good, uniform mechanical characteristics.

This process provides a middle ground between vacuum bagging and RTM. The advantage this process offers laminators is the opportunity to make and modify their own tooling without having to go to outside sources. This gives the laminator control of tooling costs, and more importantly, the ability to make changes quickly and economically. This flexibility is not available in RTM and compression molding. The elimination of overspray and bagging material waste provides another reason for considering this process.

302 PROCESS MATERIALS

Process Materials

"Traditional" general purpose (GP) orthophthalic polyester resins were widely used by the industry into the early eighties. These resins had approximately 44 - 48 percent styrene content by weight. By the mid-eighties, DCPD (dicyclopentadiene) resins became popular because of improved cosmetics due to reduced shrinkage and their cost competitiveness. DCPD blends currently have a slightly lower styrene content. However, in 1988, Rule 1162 (South Coast Air Quality Management District VOC regulation) required composite manufacturers located in a four county area in Southern California to adopt resins with a styrene content no greater than 35 percent. The tough low profile (TLP) resins which are available to meet Rule 1162 have a 33.5 to 35 percent styrene content. Reichhold Chemical, a producer of resins for the marine industry, indicates that the flexural fatigue properties deteriorate quickly when styrene levels drop below 33.5 percent. Nevertheless, the future according to one resin supplier is "no styrene." The styrene monomer will probably be replaced in the resin by a more environmentally acceptable monomer. The replacement, however, will likely be more expensive and require laminators to develop new techniques to handle the styrene-free resins.

Low Styrene Resins

Currently, low styrene resins are readily available and in use throughout industry. The most notable characteristic of these resins is the higher viscosity. This makes it more difficult for the resin to wet a surface and saturate glass fiber. Reichhold indicates that the molding surface and glass fiber should be coated with resin and allowed to wet-out 45 seconds before roll-out to give the resin a chance to interact with the binders and surface. Achieving good secondary bonding has also been mentioned as a problem because of reduced styrene levels. This is due in part because the low styrene resin is less forgiving of dust and contaminants on the laminate surface. Therefore, more attention has to be paid to surface preparation as well as following good wet-out procedures.

302.1 VAPOR SUPPRESSED RESINS

The following information on Vapor Suppressed Resins is from an article called, "Reducing Emissions with Styrene Suppressants," authored by Bob Lacovara, Director of Technical Services at the Composites Fabrication Association.

Vapor Suppressed Resins

The arsenal of styrene emissions reduction techniques for open molding includes low styrene resins, controlled spraying techniques, non-spray application, and the use of film forming agents, which reduce the evaporation of styrene monomer. These film formers are called vapor suppressants or styrene suppressants. Vapor suppressants are almost as old as the composites industry, but have enjoyed a rebirth of necessity, as a major emissions source reduction method for the open molding industry.

Vapor suppressants are a class of resin additives typically based on aliphatic wax compounds, such as paraffin, although proprietary chemistries are used in high performance formulations. The function of a vapor suppressant is to rapidly phase separate from the resin, and form a film on the surface of the curing laminate. The waxy film inhibits styrene evaporation, which results in reduced styrene emissions.

Paraffin Wax

Paraffin wax was originally used as an "air-dry additive" or "tack-free additive" to assist in curing a laminate, or a post-applied gel coat surface, so it would be sandable. Typically, sanding a cured laminate will result in "gumming-up" the sandpaper; however, once the "surface gum" is removed the laminate sands perfectly well. The reason for this is that many polyester resins are air inhibited, meaning they do not cure well while exposed to the oxygen in the atmosphere. The air inhibition, however, only occurs in a very thin layer at the surface of a laminate. The laminate may be very well cured, except for the boundary layer, which has been exposed to the atmosphere. This is particularly true for orthophthalic, isophthalic and vinyl ester resins. DCPD resins tend to air-dry on the surface and are less prone to air inhibition. The use of paraffin wax as an "air-dry" additive causes the surface to fully cure by excluding contact with the atmosphere. This results in a sandable surface. It was discovered that an incidental benefit of paraffin wax was that the film hindered styrene evaporation, through the same mechanism of excluding contact with the atmosphere.

DCPD Resins

Paraffin wax does have a downside - the wax film can reduce the bind between laminates. The reduction in inter-ply adhesion can result in serious structural failure in case of delamination. However, more sophisticated suppressant formulations incorporate adhesion promoters to enhance bonding of subsequent plies of laminate. Additionally, there is a timing issue which effects laminate adhesion. When using a vapor suppressant additive, there is an ideal window of time for applying the following laminate over a cured laminate. That window may range from 2 hours to 24 hours depending on the specific additive, resin type, laminate gel time, and ambient temperature cure conditions. Outside of the window, the laminate surface should be completely sanded to insure an adequate bond. Because adhesion is influenced by a number of factors, it is recommended that you conduct adhesion testing on your specific combination of materials and conditions.

Styrene Emissions Testing

During the course of the CFA Styrene Emissions Test Project, the effects of vapor suppressants were examined, to determine the extent of emissions reduction. As a result, an understanding of the function of suppressants has been developed.

1. Film formation only occurs when the surface is in quiescent state, that is, when not being disturbed by resin transport or by manipulating the surface with laminating tools. The implication is that the suppressant is only effective during the static (quiescent) curing phase of the emissions profile.

Comparison of Manual and Spray Applications

2. Vapor suppressants produce a large emissions reduction from the curing phase of the emissions cycle.

3. Suppressants vary in effectiveness with different combinations of suppressant and resin formulation.

4. Suppressing action varies with resin styrene content, with high styrene resins exhibiting greater overall reductions than low styrene resins.

The differences in emissions reduction between manual application and spray application are a result of the emissions profiles of these two processes. In the case of spray application, a large portion of emissions is lost during the spray transfer process. Once the resin is on the surface of the reinforcement, spray application shares the same profile as manual application. Because the vapor suppressant is not effective during the spraying stage, emissions for this portion of the profile are virtually the same as a non-suppressed system. However, once the resin is less disturbed, and finally undisturbed, the suppressant begins to take effect. With manual application, styrene loss is less during the transfer stage, therefore the proportion of emissions reduction on the back-end of the process is greater.

The other evident fact is that with manual application, higher styrene content resin exhibits a greater proportional reduction in emissions. It appears that once the suppressant film is formed on the resin surface, emissions are about the same for both high and low styrene resins. The high styrene resin emits more styrene during the transfer stage and during roll-out, so the actual amount of emissions is higher, but the proportional decrease is also greater. The result is that high styrene resins reap a greater benefit from vapor suppressants than low styrene resins in manual application. In spray application the differences are blurred across the range of styrene contents, most likely due to the influence of the magnitude of emissions during the spraying phase.

Flow Applicators

During recent testing, flow applicators have produced emissions profiles that are similar or better than manual application. The combination of a flow chopper and vapor-suppressed resin has produced emissions in the range of 1 - 2 percent of resin weight, which is extremely low. The flow chopper has an advantage over bucket and brush hand lay-up; the flow chopper is faster. The faster the resin is transferred to the laminate, the lower the emissions. Additionally, chop is generally easier to saturate and roll-out than chopped strand mat, so both the resin application stage and the roll-out stage are truncated, resulting in lower emissions.

Styrene Suppressants

Should you use a vapor suppressant? The answer is a qualified yes. Is secondary bonding an issue for your products? If you are fabricating "one shot" laminates, or if structural bonding is not an issue, you are free to use almost any type of suppressant. However, if you are fabricating products, which use multiple laminates and have structural requirements, you should approach suppressants with caution. You must select a suppressant that is effective with your specific resin system. Additionally, you must have procedures in place which specify laminate timing and/or sanding schedules. By working closely with your resin supplier, you can take maximum advantage of specifying a vapor suppressant that has the required adhesion characteristics, and is effective in reducing emissions. While styrene suppressants are not suitable for all applications, they can offer real emissions reduction benefits in a wide range of molding situations.

302.2 CATALYSTS

302.2.1 Benzoyl Peroxide (BPO)

Benzoyl Peroxide (BPO)

BPO has been reported to have a beneficial effect in suppressing styrene emissions. Part of this effect has been attributed to a reduction in gel time and a lower peak exotherm (temperature) while curing at room temperature, depending upon the reference cited. This catalyst can replace methyl ethyl ketone peroxide (MEKP) for room temperature curing, providing the proper accelerator is used in the polyester resin. Normally cobalt is included as an accelerator for polyester resin catalyzed with MEKP, however, cobalt is not an effective accelerator for BPO. If you are considering using BPO as a catalyst, your resin supplier should be consulted first.

302.2.2 UV Curing Resins

Resin Exposure to UV Lighting

These resins derive their benefits from a photo sensitive curing mechanism. UV light serves as the catalyst for this curing mechanism, which was developed over 14 years ago by BASF, a large multi-national chemical producer. This curing agent or initiator can be used in either vinylester or polyester resins. The curing process "involves the decomposition of a photo-initiator" by exposure to a particular wavelength of light. Once exposed, the decomposition produces free radicals which trigger the polymerization reaction of the resin. BASF indicates in their technical literature that laminates up to 20 mm in thickness can be cured in one lay-up using this curing mechanism. BASF will license any resin producer to use their initiator.

Pros & Cons to UV Light Exposure

302.2.3 Advantages of UV Curing Resins

* The resin requires no mixing with catalysts or promoters.
* There are no limits on processing time, hence no "pot life" concerns.
* The resin is not temperature dependent for curing.
* Once the resin is exposed to the proper wave length of light, the resin exhibits fast gelling and short curing times.
* The cure moves through the laminate starting at the surface and then moving inward. The result is limited exotherm and laminate stress.
* Evaporation of styrene is reduced because the laminate is sealed from the outside in.
* Resin not exposed to UV light can be returned to storage for re-use.
* Cleaning costs are less since the material will not cure on tools.

302.2.4 Disadvantages of UV Curing Resins

* The resin cannot be pigmented.
* Only transparent fillers can be added and then only in limited quantities.
* The geometry of the part must allow direct exposure to UV light in order for curing to take place.

302.3 LAMINATING WITH UV RESINS

Laminating Process

The laminating process can be carried out in normal shop conditions using fluorescent lights. Exposure to direct sunlight, however, will cause the resin to begin curing. Other than that precaution, the process can be carried out as you would any other lay-up method. The laminate will not begin to gel until it is moved outside for exposure to direct sunlight or placed in a room containing UV lighting.

The flexibility of being able to place and roll out a laminate without concern for gel time provides manufacturers with a great deal of flexibility in adjusting crew size. The entire part can be laid up and then cured as a complete unit. Larger work can be left "wet" during a break or interrupted for a short period of time without any adverse effects. Tools and dispensing equipment do not have to be cleaned since the resin is not gelling. Since the resin does not need to be mixed with a catalyst, the resin can be applied effectively with a flow coater or roller without a mixing and metering system.

UV Curing Cost Factors

The cost for including a UV curing mechanism in a polyvinyl resin is about $.50 per pound of resin. For high volume polyester resin users this nearly doubles the cost of the resin. The savings that can be realized from improved manufacturing flexibility and reduced styrene emissions in some circumstances may justify the additional cost. For large volume users other alternatives may prove to be more profitable in gaining similar benefits.

302.4 POLYURETHANES AND POLYURETHANE/POLYESTER BLENDS

Blends in Composites

The following information on Polyurethanes is from an article called, "Polyurethanes Take Big Steps," by A. Brent Strong, Ph.D., Brigham Young University. *(A. Brent Strong is a contributing editor to Composites Fabrication and a Professor of Manufacturing Engineering and Engineering Technology at Brigham Young University in Provo, Utah.)*

302.4.1 Overview of Polyurethanes in Composites

Polyurethanes

Almost everyone in the United States and most of the rest of the world has contributed to the growth of polyurethanes by buying sports shoes made by Nike, Reebok, Adidas, or any one of a multitude of other sports shoe manufacturers. These shoes, made mostly of polyurethane (PUR), have been extremely profitable and have contributed to the tremendous surge in the sales of polyurethane resins. But shoes are not the only market for PUR.

Polyurethane resins are used for the finest paints and can even be specifically formulated for use as a wall coating that allows graffiti to simply be washed away. Polyurethanes are also used extensively for molded plastic parts. In the medical field, polyurethanes are the materials used for artificial heart valves and even complete artificial hearts. In industrial markets, polyurethanes are made into O-rings, seals, and vibration cushions. The newest and most advanced sports clothes are made from spandex fibers, another polyurethane product. Polyurethanes are also the preferred liner materials under landfills to prevent seepage contamination. With all these new and dynamic uses, is it any wonder that polyurethanes have been combined with fiberglass and other fiber reinforcements to make new and highly innovative composite products?

Polyurethane (PUR)

The automotive industry seems to be at the forefront in the use of PUR in composite structures. Some automotive parts now being made from reinforced PUR include: bumper assemblies, exterior body panels, steering wheels, transmission deadeners, firewall deadeners, belly pans, and in related markets, RV housings and lawn tractor covers. Reinforced PUR is used in these applications because it is tougher than the competing SMC or BMC and yet is still stiff enough to hold its shape during normal use. Most of us have heard of the "dent resistant" side panels for cars and vans and the "5 mph bumper." Reinforced PUR is one of the most common materials for these applications.

One rapidly growing application for reinforced polyurethanes is in molds, especially when the mold is to be used only a few times. The excellent fluidity of polyurethanes before they crosslink allows the material to flow into small recesses and around details. After crosslinking, the polyurethanes can be tougher and harder than other competitive materials for these "soft" mold applications.

302.4.2 What are the Properties of Reinforced Polyurethane?

PUR Properties

The major property of PUR that is driving most of the applications is its toughness. This toughness comes from the high flexibility and elongation of polyurethanes. Although property comparisons between resins are hard to make because of the many grades available, as comparison of elongation of a general casting polyurethane with 55 percent fiberglass reinforcement shows elongations from 5 to 55 percent whereas polyester SMC would typically have a maximum elongation of 5 percent.

PURs can be flexible or stiff. Some specialty grades of reinforced PUR have elongations as high as 600 percent and are, therefore, considered elastomers. Polyurethanes can have tensile strengths as high as 2000 - 7000 psi and Shore hardness as high as 90D. These properties lead to an ability of some PUR sheets to deflect 6 to 8 inches at -20° F repeatedly. Polyurethanes are, therefore, especially useful for cryogenic applications.

Stiffness, generally measured by flexural modulus, is chiefly a function of the amount of glass reinforcement in polyurethanes, just as it is in polyesters, although the matrix stiffness does have some effect. Polyester resins are generally stiffer than polyurethanes (polyurethanes have a wider range of stiffness, including some that are quite flexible), and so the composites of polyesters are, on the average, stiffer than polyurethane composites.

Thermal Capabilities of PURs

What about the thermal capability of PURs? The sag values of PUR reinforced with 20 - 30 percent fiberglass are 0.05 inch at normal automotive painting temperatures (325 - 360° F). The sag can be reduced significantly by additional crosslinking, but this results in more brittleness at room temperature. Therefore, reinforced PUR materials are not currently used for horizontal automotive exterior panels because of excessive sag. SMC would be the plastic choice for these horizontal applications.

Polyurethanes also generally make better adhesives than polyesters. Therefore, adhesion to fiber reinforcements is better across a wide range of reinforcements. This adhesion is also an advantage when the reinforced part is to be bonded into an assembly or covered with another coating.

Mechanical Properties of PUR

If PUR's mechanical properties are competitive and sometimes better than polyesters, what about the surface smoothness and paintability which are so often critical for exterior automotive parts? Smooth surfaces are not a problem with PURs. They can be easily molded to a Class A surface. Paintability has been a little more difficult to achieve. After 1000 hours in a weathermeter, gloss is significantly lost, but can be regained to near original values with washing and waxing.

Abrasion Resistance

Another property that is leading to increased sales of PUR is abrasion resistance. Reinforced PUR materials have Taber resistances far better than most other plastic materials. This advantage is one of the principle reasons PURs are so widely used in athletic shoes.

302.4.3 What Manufacturing Methods Are Used to Make Polyurethanes?

Manufacturing Methods

Polyurethanes can be both thermoplastics and thermosets and can be both reinforced and nonreinforced. PURs are readily manufactured by almost all of the traditional manufacturing methods including extrusion, injection molding, thermoforming, and blow molding (for thermoplastics) and lay-up, spray-up, compression molding, and casting (for thermosets).

Reaction Injection Molding (RIM)

In addition, some special manufacturing methods have been developed to take advantage of the unique characteristics of polyurethanes. The most important of these unique characteristics is the two-part nature of the reactive liquid components which are mixed in nearly equal volumes. When mixed, these components (usually called polyol and the isocyanate) will react very quickly, thus allowing short cycles. Pressures are lower than needed for thermoplastic injection molding because the viscosities of the liquid materials are usually much lower than the vicosities of a molten thermoplastic. The process designed to take advantage of these polyurethane characteristics is called reaction injection molding (RIM). The RIM process uses two storage chambers which contain the polyol and isocyanate, much like storage containers, are nearly the same size and have nearly the same pumping volume. These liquids are pumped into a mixing head where the materials are both mixed and metered (pumped) into the mold, which is closed during the injection. After a few seconds or, at the longest, a few minutes, the reaction of the two components is complete and the part is solid. The mold then opens and the part is removed.

Automotive Industry

The automotive industry has used the RIM process extensively because of its low emissions (no solvents and closed mold) and its rapid cycle time, especially for thick parts. The automotive industry has also pioneered the use of reinforcements in the RIM process. If the reinforcements are chopped fibers (usually small whiskers), the process is called reinforced reaction injection molding (RRIM). In the process, the fibers are mixed into one of the reactants in the storage container and they flow with that reactant into the mold. The pressures required for pumping are somewhat higher than traditional RIM because of the higher viscosity of the fiber-filled liquid, but even then, the pressures are less than in thermoplastic injection molding.

Mold Reinforcements

Another method of adding reinforcement is to have the reinforcement in the mold prior to the entrance of the reactants. This method allows the use of long fibers, usually in the form of mat or cloth that is wrapped around a foam core for creating a preform. This process is called structural reaction injection molding (SRIM.) The fibers are wetted by the resins and the reinforcement is therefore encapsulated and held in shape by the polyurethane matrix. Because of the low viscosity of the injected fluids, only low pressures are required in the SRIM process and the molds can be made of a wide variety of materials, though usually they are made of aluminum or soft steel.

Structural Reaction Injection Molding (SRIM)

Newer RIM, RRIM, and SRIM machines can fill a 40 pound mold in under one second, usually at slightly higher pressures than were common in the past for these processes. Recent studies on mold filling mechanisms have shown that evacuation of the mold cavity substantially decreases fill time. These studies have led to some interesting optimizations of structural requirements and fill time tradeoffs.

This process is similar to RTM which is used to make reinforced polyester and epoxy parts, with a few notable differences. RTM usually does not use a mixing head, rather, it depends on an in-line mixer. To get the mixing desired with only an in-line mixer, the viscosities of the liquid reactant must be very low, and therefore, pressures in RTM can be even lower than those needed in RIM or SRIM. As with SRIM, a preform is placed in the mold prior to the injection of the resin, thus preserving the low viscosity of the reactants. The preform used with RTM is often chopped fiber preform which has been shaped externally and is then placed in the RTM mold prior to closing it and injecting the reactants.

Processes employing PUR resins contain no volatile solvents and require no peroxide initiators or accelerators. Mixing of the PUR materials is generally easier than with polyesters because the PUR components are mixed nearly 1:1, thus simplifying the mixing scheme. Reaction times for the PUR processes are generally much faster than for polyesters. If needed, catalysts (non-peroxide) can be added to the PUR materials to make the cure faster, but difficulty is encountered when trying to slow down the reaction of the polyol and isocyanate. Wetout of the fibers is relatively easy in all cases. Pressures are highest among these processes in the RRIM process and lower in those which pump only neat liquids (without reinforcements.)

Reinforced Polyurethanes

Reinforced polyurethane parts can also be made by spray-up and wet lay-up techniques. In both of these manufacturing methods, normal mixing and spraying equipment is used, with some minor alterations to allow for the nearly equal mixing of the two polyurethane components. The molds for PURs would be about the same type as used for reinforced polyester. Parts made by spray-up of polyurethanes include tailgates for salt-spray trucks (where the superior salt resistance of PUR over polyester is the consideration) and several parts which come into contact with gasoline (superior solvent resistance.)

Reinforced polyurethanes have been successfully pultruded and filament wound, again, without many modifications in the manufacturing apparatus except to inject the reactive components into the die rather than use a resin bath. Neither pultrusion nor filament winding have, however, gained the acceptance of RRIM or spray-up.

Polyurethanes can be easily cast. Some of the important applications for this method would be conveyor belts and liners for mining applications. Some PUR belts have met FDA approval for food contact applications and their use as a matrix over flexible cloth or fibers for food processing belts is growing rapidly.

In all of these manufacturing methods, one major difference in handling of the materials should be noted. One of the components used to make polyurethanes is isocyanate. This material reacts with water and can, therefore, be hazardous. It should not be allowed to come in contact with skin or eyes. Normal precautions are usually sufficient (goggles, gloves, long sleeves, etc.,) but a high reactivity should be a constant safety consideration.

Polyurethanes can be both thermosets and thermoplastics. As thermosets, two components (isocyanate and polyol) are reacted. Both components are available in a wide variety of types and grades to provide an extremely wide range of properties. The thermoplastic materials are available, as are most thermoplastics, in pellet form. Both non-reinforced and reinforced pellets can be purchased commercially. The reinforced pellets contain very short fibers at up to about 35 percent loading, typical of other reinforced thermoplastics.

302.4.4 What Are the Major Limitations to Reinforced Polyurethanes?

Limitations to Reinforced Polyurethanes

The most serious limitation is simply cost. Polyurethanes cost from $.75 to $1.00 per pound in the least expensive grades and are more typically $1.80 per pound in the grades that would be used with fiberglass reinforcement. Some authorities have suggested that polyurethanes have some problems with flammability that are not present in polyesters. Two issues have been raised. One is the possibility of formation of HCN, a highly toxic gas. Although this gas may be present in smoke from PURs, the levels detectable are quite small and are generally lost amidst all of the other off-gases and combustion products. Another issue raised against PUR flammability characteristics is the low amount of internal oxygen compared to many other plastic resins, such as polyesters. The critics suggest that this lower oxygen content will lead to the formation of more carbon monoxide, which is poisonous, rather than the harmless carbon dioxide. However, little evidence to support these suppositions has been widely distributed and accepted. Therefore, although some concerns have been raised with PUR flammability characteristics, they have not been carefully demonstrated. PUR materials will, however, burn, as do many plastics. Some progress has been made in reducing the flammability of PURs with other polymer systems, but as of yet, no common reinforced PUR material can meet stringent flammability requirements for U.S. Navy applications.

In general, polyurethanes are not going to replace polyesters, except when the unique properties or processing advantages are significant. The most important properties are flexibility, toughness, abrasion resistance, solvent resistance, and good adhesion. The advantages in processing are shorter cure cycles, some unique processing methods, and the lack of volatile solvents or co-reactants. With these advantages, applications of reinforced polyurethanes will continue to develop. Some will be as replacements for polyesters, but the majority are more likely to be as replacements for other materials or as totally new applications. This latter consideration is one of the challenges of the reinforced plastics industry. Can the industry expand by using current manufacturing technologies and new materials to enter new markets? Reinforced polyurethanes may have just the combination of properties that leads to some of these new markets.

303 CLEAN-UP OPERATIONS

Clean-Up

During each separate phase of the gel coat and resin application process, the cleaning of hands, tools, and spray guns is a very important part of the production cycle. Cleaning is needed for hands (although gloves should always be worn during the application processes), brushes, rollers, squeegees, and spray guns, generally with a solvent (usually acetone) after each application of resin. The cleaning prevents resin from curing on the tools or in the spray guns which would render the equipment unusable. Spray guns are flushed with solvent after each use and are thoroughly cleaned daily. Most resin guns contain a clean solvent-supply line on the gun to flush internal parts after each use (see Operator Training [301.2.2] and Where Should Controlled Spraying Be Used [301.2.3].)

Cleaning solvent is usually available in 2-gallon containers for hand cleansing, 5-gallon containers for tool cleaning, and 3-5 gallon containers for spray gun cleaning. Spray gun cleaning systems have also emerged, made especially for spray gun cleaning.

Soap and water solutions have also been used for tool cleaning and hand cleansing, however, this process requires rigorous brushing of parts with the part being hung above the reservoir to allow for the draining of water. An additional rinse with acetone removes water from the parts which would cause some metal parts to rust. Dibasic Ester (DBE) has been used to some extent in the effort to wean from the use of acetone, as explained below in further detail.

303.1 ALTERNATIVES TO ACETONE

Acetone

There are two groups of acetone replacements that have emerged as effective alternatives for laminators. Unfortunately, most laminators will probably have to use both replacements while still retaining the use of a small amount of acetone for special cleaning problems. The first group consists of high flash point solvents which on the whole significantly reduce the risk of fire when compared to acetone. Some of the most popular solvents in this group are:

1. Diacetone Alcohol (DAA);
2. Dibasic Ester (DBE);
3. N-methyl Pyrrolidone (NUT); and,
4. Propylene Carbonate (dioxolanone).

These solvents tend to be more expensive than acetone, however, they are less volatile and have a longer usable life. Also, most of these solvents can be effectively recycled. Consequently, many of the solvent suppliers are able to provide recycling services or can recommend a source for recycling.

Alternatives to Acetone

The second group of acetone replacements is water-based resin emulsifiers or detergent cleaners, as mentioned on the previous page. To use these cleaners effectively, a company will have to provide wash tanks (heated tanks improve cleaning action) and fixtures to facilitate soaking and scrubbing tools. These tanks can be quite inexpensive and are easily fabricated in a maintenance shop. One plant, for example, used 5-gallon buckets with each one fitted with two scrub brushes permanently mounted on a rack suspended in the bucket. This arrangement provided a means for soaking tools and using the brushes for scrubbing off the residue that remained after soaking. Once the tools are clean, they can be dried by dipping the tool or brush in a small pail of acetone. Because the primary cleaning is done by the resin emulsifier, this small quantity of acetone is changed very infrequently. Although this cleaning process is more complex than using acetone alone, it has some significant safety and cost advantages. One of the major advantages is disposing of waste. When the tanks are emptied, the liquid (the solids in the bottom of the tank are trapped and disposed of separately), can be discharged into a sanitary sewer. However, before this is done, a company must notify the municipal authorities and receive permission to do this.

Your sewer authority may require some testing, but this is neither difficult to do nor prohibitively expensive. The cost of the material is also a factor for switching away from acetone. Most resin emulsifiers are very economical when diluted with water to their working strength. Work is ongoing to improve the new solvent substitute products and to eliminate the final use of acetone.

Most district rules require cleaning with compounds with less than 1.7 pounds of VOC/gallon (200 grams per liter), and also require that containers be kept closed when not in use. Any rags containing VOCs (styrene) or other VOC-containing materials are also required to be kept in closed containers.

304 ADD-ON CONTROLS

Add-On Controls

There are four types of add-on control equipment: incineration, absorption, adsorption, and condensation.

304.1 INCINERATION

Thermal or catalytic incinerators are available to control emissions from spray booths, ovens, and room exhausts.

Incinerators

In a thermal incinerator the solvent-laden air is exposed to a temperature of 1400° to 1500°F and direct flame contact for a period of 0.3 to 0.6 seconds. In the catalytic incinerator the operating temperatures are 600° to 750°F. In either case, the important incineration design factors are: waste gas stream flow rate, residence time, temperature, and waste gas heat content. Both incinerators can be designed to achieve 90 to 99 percent removal efficiency. In some districts, however, incinerators have not, in general, been used as an emission-control device in polyester resin operations. (One fabricator uses incineration only when the VOC emissions exceed a certain limit so it can comply with New Source Review regulations.) Incineration is most effective when the pollutant to be controlled is at a high concentration and has a high heating value. Polyester resin operations typically have low VOC concentrations in their exhausts and high exhaust air flows. Conditions such as these result in low heat content exhaust streams, leading to high supplemental fuel requirements and increasing operating costs, making incineration too costly for most polyester resin operations.

304.2 ABSORPTION

Absorption

Through the use of absorption, styrene emissions are removed from the exhausting contaminated air stream by direct contact with a liquid. The absorption takes place by a chemical reaction with one or more components, sodium hydroxide or a mixture or sodium hydroxide and sodium hypochlorite, in the water-based liquid. The estimated control efficiency is at least 70 percent.

304.3 ADSORPTION

Adsorption

Carbon adsorption is a common control technique for removing VOC emissions from an air stream. When the carbon reaches the saturation point, hot air or steam is used to regenerate the adsorbent carbon. However, activated carbon can serve as a catalytic agent for the polymerization of some monomers. If high molecular weight polymers are produced, then the adsorbent surface can become fouled and regeneration may not be possible. Also, the presence of acetone emissions in the air stream could reduce the adsorption efficiency, since acetone has a relatively high heat of adsorption, thereby, system effectiveness is reduced when the temperature rises. In addition, particulate matter generated in the process (sanding dust, etc.) can clog the adsorbent, thereby reducing its effectiveness and increasing the pressure drop through the system.

304.4 CONDENSATION

Condensation

There are two types of condensers. The first type is a surface condenser where exhaust air stream is cooled with a fluid, but does not come into direct contact with the air. The second type is a contact condenser where the exhaust air stream is sprayed with a chilled liquid. Both types are generally not practical because most polyester resin operations exhausts have VOC concentrations below 1000 ppm, and condensers work effectively with higher VOC streams.

304.5 EMISSION SOURCES

Emission Controls

There are generally two major sources of VOC emissions from polyester resin/ fiberglass operations: the resin used in the manufacturing processes and the solvent from the cleanup operations during and after the manufacturing processes.

VOC emissions will depend on the amount of materials used, the type of products made, manufacturing methods, and business activity. The most common monomer used is styrene. Evaporation of styrene from gel coat or resin during the raw material application process and during the curing period is the main source of VOC emissions. It is estimated that up to 10 percent of the resin is lost as overspray or by evaporation during the raw material application process. In addition, up to 8 percent of the styrene monomer in the applied resin or gel coat evaporates before polymerization is complete. There are many other factors that impact the styrene evaporation, such as gel time, temperature and air flow.

304.6 EMISSION CONTROL TECHNIQUES

The three control techniques are: process changes to control monomer emissions, material changes for control of acetone emissions, and add-on control equipment.

304.7 MODIFICATIONS TO MATERIAL

Reducing the resin content can reduce emissions. This can be accomplished by either redesigning the products to require less resin or using more fillers and colorants. Most of the time, however, it is difficult to achieve the desired product properties by reducing the resin content.

Modifying Materials

The conversion to low monomer type resins (35-weight percent) compared to the conventional resins (40 to 50-weight percent) is a viable method for the control of some of the emission problems described previously. Low monomer type resins are readily available (see Section 302.2 Catalysts.) The cost of low monomer resins is slightly higher than the cost of conventional resins. The reduction in total styrene resin is replaced by a low styrene resin.

Reducing resin molecular weight is another way to reduce emissions. At only 35 percent styrene, the resin would exhibit a low enough viscosity to readily wet the reinforcement materials. Unfortunately, resin with low monomer content might be unacceptable for the manufacture of some products because the resin would be more viscous and difficult to spray, mold, or inject. In addition, reduction in molecular weight is usually accomplished by a corresponding loss of desired properties (be they mechanical or physical) which could also severely limit the acceptability of some products.

Photoinitiator resins are one-component resins which cure polyester resin products when exposed to long-wave ultraviolet light. Photoinitiator resins were developed in the late 1980s. The most significant advantage of this system is the rapid curing (less gel time.) Also, the cure develops from the outside, which greatly limits styrene evaporation. Other advantages include:

* a rapid and controlled rate of cure;
* no mixing and metering of raw materials is required;
* there is minimal waste from unused resin; and
* less cleaning is needed between resin applications.

Initial testing of this modified resin showed a 40 percent reduction in emissions compared to the emissions from the conventional resin. The photoinitiator additive could be added to produce most of the polyester resin products that are up to one inch thick.

A final option is the replacement of part or all of the styrene with another monomer. The search for such a monomer has been the subject of research by many companies for some time with little or no results. The ideal material is a monomer with all of the desirable qualities of styrene (good thinning capacity, good mechanical properties, and ease of polymerization); and one which is a low VOC emitter, and is cost effective as a styrene substitute.

304.8 SUPPRESSED RESINS

Suppressed Resins

Suppressed resins provide a promising technology today for reducing VOC emissions. These resins decrease VOC emissions by entrapping some of the monomer that would otherwise vaporize during the exothermic curing of the resin. The suppressing agent consists of paraffin or wax-like materials that are added to the polyester resin. The paraffin builds a film on the surface of the laminate which physically blocks the polymer surface from oxygen in the air and at the same time reduces styrene evaporation.

Suppressed resins will reduce VOC emissions by about 40 percent, by weight. These resins are priced slightly higher than the conventional resins; however, suppressed resins will achieve material savings which should offset the difference in price. Filled resins are not affected by suppressants (U.S. EPA, Geddes Ramsey at (919) 541-7963). Different brands of suppressed resins vary in performance and method of suppression. A few manufacturers did experience difficulty with delamination, a separation between layers of applied resin. This happens because the suppressed resin leaves a thin film of wax on the surface which can be detrimental to the adhesion of a subsequent lamination which then needs to be removed before further processing.

304.9 EMISSION REDUCTIONS

Reducing Emissions

Three methods of reducing styrene emissions are: correction of employee work habits, reclamation of spent styrene, and use of solvent substitutes.

304.10 CORRECTION OF EMPLOYEE WORK HABITS

Work Habits

Even though acetone is no longer considered a VOC in California, improper handling of this solvent can affect your insurance annuity due to the fact that it is a highly flammable substance.

Work Habits

Acetone is usually available for each employee in a 2-gallon container for hand cleaning, a 5-gallon container for tool cleaning, and a 5-gallon container for spray gun cleaning. Also, most spray guns have a clean acetone feed line to flush the internal parts after each use (see Section 303.)

Many fabricators' practices and work habits when handling and using acetone are less than ideal. Limiting the issuance of acetone to the employee, and proper training and diligent supervision with regard to the proper use and handling of acetone, will reduce your liability. These steps are also effective for reducing styrene emissions by allowing plant management to observe employee work habits.

304.11 RECLAMATION OF SPENT ACETONE

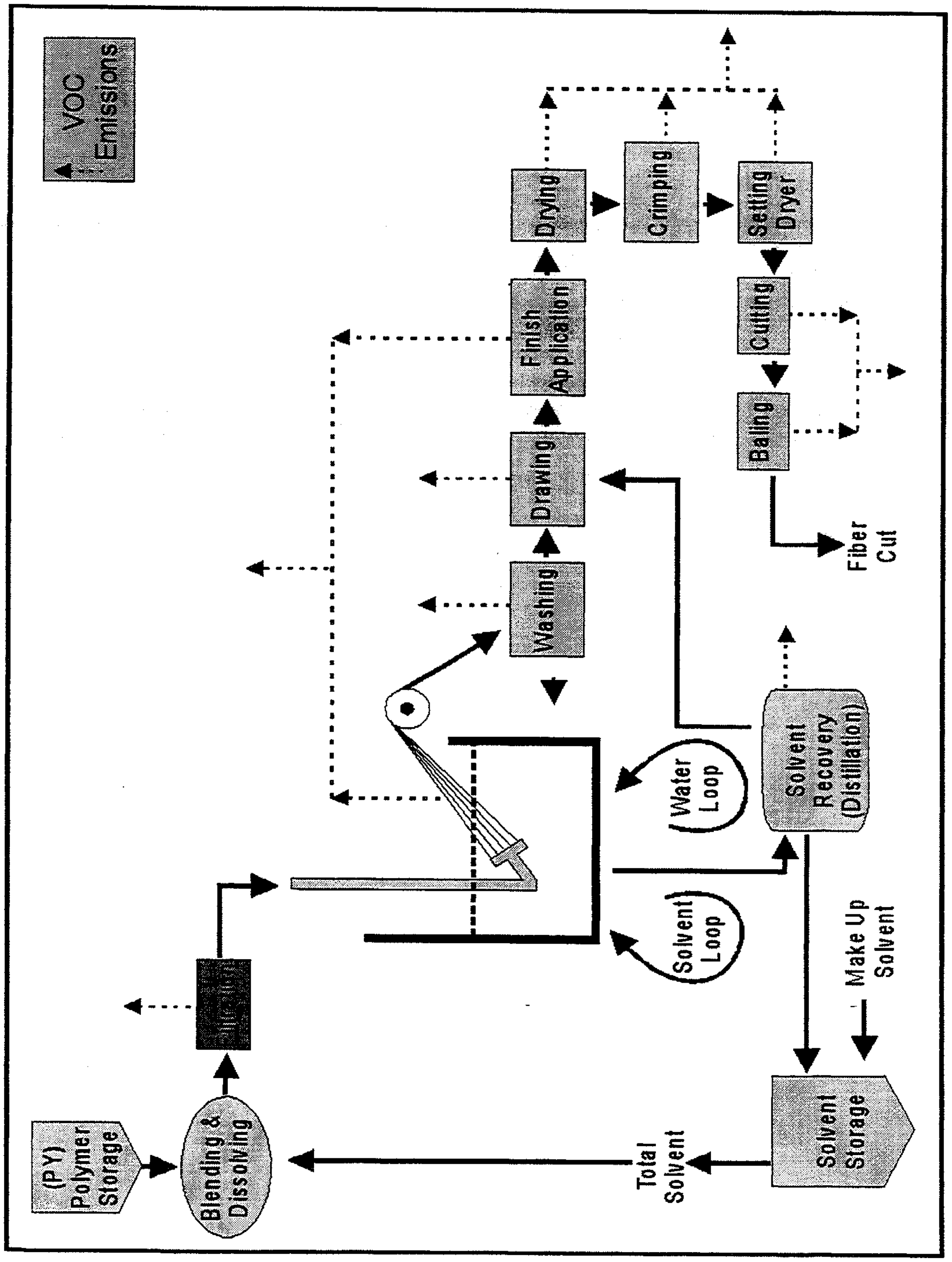
Reclamation of Spent Acetone

There are two options for the control of spent acetone: on-site recovery or off-site recovery at a commercial solvent reclaiming facility; both offer economic and environmental benefits.

Some manufacturers dispose of spent acetone by allowing it to sit in open containers and evaporate. On-site acetone reclamation through the use of a distillation unit can reduce this loss. These units are available in different sizes in order to be compatible with the needs of various polyester resin operations. These units come completely assembled and can recover 90 to 97 percent of the solvent that is otherwise lost. This approach should help reduce the problems associated with the storage of dirty solvents.

Some polyester resin manufacturers dispose of spent acetone at an off-site dump. Practices like this will contribute to liability/safety issues at the dump site. Instead, spent acetone should be sent to commercial facilities that specialize in reclaiming acetone as well as other solvents. An additional benefit of this method is that the polyester resin fabricator can also have the off-site reclamation facility dispose of solid waste included in the spent acetone. Again, these steps are also effective for reducing styrene emissions.

Figure 300.19 on the following page illustrates the VOC emissions from fiber processing operations.



Source: U.S. EPA, *AP-42*, Office of Air and Radiation, 1993.

Figure 300.19: VOC Emissions from Fiber Processing Operations

305 SUMMARY OF SELECTED CHEMICALS RELEASED

Toxic Release Chemical Inventory (TRI)

The following is a synopsis of current scientific toxicity and fate information for the top chemicals (by weight) that plastic resin and manmade fiber facilities released to the environment in 1995. Ethylene glycol is mentioned also because it accounts for a large portion of the transfers for the industries. The top chemicals were selected based on Toxic Chemical Release Inventory (TRI) release data that facilities self-reported. Because this section is based on self-reported release data, it does not attempt to provide information on management practices employed by the sector to reduce the release of these chemicals. Information regarding pollutant releases reductions over time may be available from EPA's TRI and 33/50 programs, or directly from industrial trade associations.

HSDB

IRIS

TOXNET

CCRIS

DART

DBIR

EMICBACK

GENE-TOX

RTECS

The brief descriptions provided were taken from the 1994 Toxics Release Inventory Public Data Release (EPA, 1995), the Hazardous Substances Data Bank (HSDB), and the Integrated Risk Information System (IRIS), all accessed via TOXNET. TOXNET is a computer system run by the National Library of Medicine that includes a number of toxicological databases managed by EPA, National Cancer Institute, and the National Institute for Occupational Safety and Health. For more information on TOXNET, contact the TOXNET help line at 800-231-3766. Databases included in TOXNET are: CCRIS (Chemical Carcinogenesis Research Information System), DART (Developmental and Reproductive Toxicity Database), DBIR (Directory of Biotechnology Information Resources), EMICBACK (Environmental Mutagen Information Center Backfile), GENE-TOX (Genetic Toxicology), HSDB (Hazardous Substances Data Bank), IRIS (Integrated Risk Information System), RTECS (Registry of Toxic Effects of Chemical Substances), and TRI (Toxic Chemical Release Inventory). HSDB contains chemical-specific information on manufacturing and use, chemical and physical properties, safety and handling, toxicity and biomedical effects, pharmacology, environmental fate and exposure potential, exposure standards and regulations, monitoring and analysis methods, and additional references.

The discussions of toxicity describe the range of possible adverse health effects that have been found to be associated with exposure to these chemicals. These adverse effects may or may not occur at the levels released to the environment. Individuals interested in a more detailed picture of the chemical concentrations associated with these adverse effects should consult a toxicologist or the toxicity literature for the chemical to obtain more information.

305.1 ACETONITRILE; CHEMICAL MANUFACTURERS ASSOCIATION (CAS: 75-05-8)

305.1.1 Sources

Acetonitrile

Acetonitrile may be generated as a byproduct of acrylonitrile manufacture and may be used as a solvent in butadiene extraction processes.

305.1.2 Toxicity

Toxicity

Toxicity may be caused through ingestion, inhalation, or dermal exposure. Exposure to acetonitrile may lead to cyanide poisoning by metabolic release of cyanide after absorption. Toxicity can be prolonged. Individuals exposed to slight concentrations may develop nausea, vomiting, headache and lassitude, respiratory depression, shock, coma, and seizures. Pulse may become rapid, weak, and sometimes irregular. Lactic acidosis is common after oral ingestion, as a result of the conversion to cyanide. Chronically exposed patients may develop headache, lack of appetite, dizziness, weakness, and dermatitis. In one study, exposures of 40 to 160 ppm for four hours resulted in no symptoms or only mild symptoms. A dose of 0.006 mg of acetonitrile per kg body weight per day is expected to result in no adverse effects if an individual is exposed to this dose for a lifetime. This dose level was determined from a study which found decreased red blood cell counts and hematocrit, and hepatic lesions in mice exposed to acetonitrile for 90 days.

305.1.3 Carcinogenicity

Carcinogenicity

There is currently no long-term human or animal data to suggest that this chemical is carcinogenic in humans.

305.1.4 Environmental Fate and Potential for Human Exposure

Environmental Fate

Human Exposure

Biodegradation is likely to occur if it is released to soil. It is also mobile in soil and may evaporate from the surface of soil. In water, the major loss process is biodegradation. Acetonitrile will persist in the troposphere for a long time and may be transported a long distance from the source of its release. Wet deposition may remove some of the atmospheric acetonitrile.

305.2 CARBON DISULFIDE (CAS: 75-15-0)

305.2.1 Sources

Carbon Disulfide

Carbon disulfide is used in a variety of industrial applications including the manufacture of regenerated cellulose rayon and cellophane, and in the production of rubber.

305.2.2 Toxicity

Toxicity

Short-term (acute) exposure of humans to carbon disulfide can cause headaches, dizziness, fatigue, and irritation of eyes, nose, and throat. Exposure to high concentrations may result in trouble breathing or respiratory failure. Contact with skin can cause severe burns.

Long-term (chronic) exposure to high levels in excess of regulatory standards may result in peripheral nerve damage (involving the nerves that control feet, legs, hands, and arms) and cardiovascular effects. A few studies contend that chronic exposure may also result in potential reproductive effects.

305.2.3 Carcinogenicity

Carcinogenicity

There are no long-term human or animal data to suggest that this chemical is carcinogenic in humans.

305.2.4 Environmental Fate

Environmental Fate

If released on land, carbon disulfide will be primarily lost to volatilization and it may leach into the ground where it would be expected to biodegrade. The chemical will also volatilize if released to water and does not adsorb to sediment. In air, carbon disulfide reacts with atomic oxygen to produce hydroxyl radicals with half-lives of a few days. Carbon disulfide gas is adsorbed and degraded by soil, which demonstrates that soil may be a natural sink for this chemical. The general population may be exposed to carbon disulfide primarily from ambient air as it is released not only from industrial sources, but also from a wide variety of natural sources.

305.3 ETHYLENE (CAS: 74-85-1)

305.3.1 Sources

Ethylene

Ethylene is used to make polyethylene, polypropylene, polystyrene, polyester, and polyvinyl chloride resins. Ethylene is the monomer used to make high-density polyethylene, low-density polyethylene, and linear low-density polyethylene.

305.3.2 Toxicity

Toxicity

Ethylene has been used as an anesthetic; the effects reported here are related to its properties as an anesthetic. Asphyxia may occur from breathing ethylene in enclosed spaces and in cases where the atmospheric oxygen has been displaced to about 15 to 16 percent or less.

305.3.3 Carcinogenicity

Carcinogenicity

According to the International Agency for Research on Cancer, there is inadequate evidence in humans and animals to suggest carcinogenicity in humans.

305.3.4 Environmental Fate

Environmental Fate

In the air, ozone, nitrate radicals, and hydroxyl radicals may degrade ethylene. In water and soil, ethylene may be oxidized to produce ethylene oxide, and the chemical may permeate soil and sediment. The major environmental fate process is volatilization. The most probable way humans are exposed is by inhaling ethylene from contaminated air.

305.4 ETHYLENE GLYCOL (CAS: 74-85-1)

Ethylene Glycol

305.4.1 Sources

Ethylene glycol is used to make polyethylene terephthalate (PET.) It is also used in the manufacture of alkyd resins and as a solvent mixture for cellulose esters and ethers. Over 75 percent of ethylene glycol releases are by means of point and fugitive air emissions.

Toxicity

305.4.2 Toxicity

Long-term inhalation exposure to low levels of ethylene glycol may cause throat irritation, mild headache and backache. Exposure to higher concentrations may lead to unconsciousness. Liquid ethylene glycol is irritating to the eyes and skin.

Toxic effects from ingestion of ethylene glycol include damage to the central nervous system and kidneys, intoxication, conjunctivitis, nausea and vomiting, abdominal pain, weakness, low blood oxygen, tremors, convulsions, respiratory failure, and coma. Renal failure due to ethylene glycol poisoning can lead to death.

Environmental Fate

305.4.3 Environmental Fate

Ethylene glycol readily biodegrades in water. No data are available that reports its fate in soils; however, biodegradation is probably the dominant removal mechanism. Should ethylene glycol leach into the groundwater, biodegradation may occur.

Ethylene glycol in water is not expected to bioconcentrate in aquatic organisms, adsorb to sediments or volatilize. Atmospheric ethylene glycol degrades rapidly in the presence of hydroxyl radicals.

Hydrochloric Acid

305.5 HYDROCHLORIC ACID (CAS: 7647-01-1)

305.5.1 Sources

Hydrochloric acid can be generated during plastic resin manufacture.

Toxicity

305.5.2 Toxicity

Hydrochloric acid is primarily a concern in its aerosol form. Acid aerosols have been implicated in causing and exacerbating a variety of respiratory ailments. Dermal exposure and ingestion of highly concentrated hydrochloric acid can result in corrosivity.

Ecologically, accidental releases of solution forms of hydrochloric acid may adversely affect aquatic life through a transient lowering of the pH (i.e., increasing the acidity) of surface waters.

305.5.3 Carcinogenicity

There is currently no evidence to suggest that this chemical is carcinogenic.

305.5.4 Environmental Fate

Releases of hydrochloric acid to surface waters and soils will be neutralized to an extent due to the buffering capacities of both systems. The extent of these reactions will depend on the characteristics of the specific environment.

305.5.5 Physical Properties

Concentrated hydrochloric acid is highly corrosive.

305.6 METHANOL (CAS: 67-56-1)

305.6.1 Sources

Methanol can be used as a solvent in plastic resin manufacture. Methanol is used in some processes to make polyester, although many companies have converted to newer process methods that do not use methanol (AFMA, 1997b.)

305.6.2 Toxicity

Methanol is readily absorbed from the gastrointestinal tract and the respiratory tract, and is toxic to humans in moderate to high doses. In the body, methanol is converted into formaldehyde and formic acid. Methanol is excreted as formic acid. Observed toxic effects at high dose levels generally include central nervous system damage and blindness. Long-term exposure to high levels of methanol via inhalation cause liver and blood damage in animals.

Ecologically, methanol is expected to have low toxicity to aquatic organisms. Concentrations lethal to half the organisms of a test population are expected to exceed one mg methanol per liter water. Methanol is not likely to persist in water or to bioaccumulate in aquatic organisms.

305.6.3 Carcinogenicity

There is currently no evidence to suggest that this chemical is carcinogenic.

Environmental Fate

305.6.4 Environmental Fate

Liquid methanol is likely to evaporate when left exposed. Methanol reacts in air to produce formaldehyde which contributes to the formation of air pollutants. In the atmosphere it can react with other atmospheric chemicals or be washed out by rain. Methanol is readily degraded by microorganisms in soils and surface waters.

Physical Properties

305.6.5 Physical Properties

Methanol is highly flammable.

Other Data Sources

305.7 OTHER DATA SOURCES

The toxic chemical release data obtained from TRI captures the vast majority of facilities in the plastic resin and manmade fiber industries. It also allows for a comparison across years and industry sectors. Reported chemicals are limited, however, to the 316 reported chemicals. Most of the hydrocarbon emissions from organic chemical facilities are not captured by TRI. The EPA Office of Air Quality Planning and Standards has compiled air pollutant emission factors for determining the total air emissions of priority pollutants (e.g., total hydrocarbons, particulates, etc.) from many chemical manufacturing sources.

AIRS

The EPA Office of Air's Aerometric Information Retrieval System (AIRS) contains a wide range of information related to stationary sources of air pollution, including the emissions of a number of air pollutants which may be of concern within a particular industry. With the exception of VOCs, there is little overlap with the TRI chemicals reported above. Table 300.5 summarizes air pollutant releases by industry sector (tons per year.)

Comparison of TRI

305.8 COMPARISON OF TOXIC RELEASE INVENTORY BETWEEN SELECTED INDUSTRIES

The information contained in Table 300.6 is presented as a comparison of pollutant release and transfer data across industrial categories. It is provided to give a general sense as to the relative scale of releases and transfers within each sector profiled under this project. Table 300.6 does not contain releases and transfers for industrial categories that are not included in this project, and thus cannot be

TRI Data

used to draw conclusions regarding the total release and transfer amounts that are reported to TRI. Similar information is available within the annual TRI Public Data Release Book.

Table 300.6 is a representation of a summary of the 1995 TRI data for the plastic resin and manmade fibers industries and the total sectors profiled in separate notebooks. This table is meant to facilitate comparisons between the relative amounts of releases, transfers, and releases per facility both within and between these sectors. It should be noted, however, that differences in the proportion of facilities captured by TRI exist between industry sectors. This can be a factor of poor SIC matching and relative differences in the number of facilities reporting to TRI from the various sectors. In the case of the plastic resin and manmade fiber industries, the 1995 TRI data presented here covers 469 facilities. Only those facilities listing SIC Codes falling within SIC 2821, 2823, and 2824 were used.

Table 300.7 illustrates the regulated components, pollutants, and performance standards for polyester resin operations only in California, along with a rule/ measure/date from the enforcing air pollution control/air quality management districts within California.

Table 300.5: Air Pollutant Releases by Industry Sector (tons/year)

Industry Sector	CO	NO_2	PM_{10}	PT	SO_2	VOC
Metal Mining	4,670	39,849	63,541	173,566	17,690	915
Nonmetal Mining	25,922	22,881	40,199	128,661	18,000	4,002
Lumber & Wood Production	122,061	38,042	20,456	64,650	9,401	55,983
Furniture & Fixtures	2,754	1,872	2,502	4,827	1,538	67,604
Pulp & Paper	566,883	358,675	35,030	111,210	493,313	127,809
Printing	8,755	3,542	405	1,198	1,684	103,018
Inorganic Chemicals	153,294	106,522	6,703	34,664	194,153	65,427
Organic Chemicals	112,410	187,400	14,596	16,053	176,115	180,350
Petroleum Refining	734,630	355,852	27,497	36,141	619,775	313,982
Rubber & Misc. Plastics	2,200	9,955	2,618	5,182	21,720	132,945
Stone, Clay, & Concrete	105,059	340,639	192,962	662,233	308,534	34,337
Iron & Steel	1,386,461	153,607	83,938	87,939	232,347	83,882
Nonferrous Metals	214,243	31,136	10,403	24,654	253,538	11,058
Fabricated Metals	4,925	11,104	1,019	2,790	3,169	86,472
Electronics & Computers	356	1,501	224	385	741	4,866
Motor Vehicles, Bodies, Parts & Accessories	15,109	27,355	1,048	3,699	20,378	96,338
Dry Cleaning	102	184	3	27	155	7,441
Ground Transportation	128,625	550,551	2,569	5,489	8,417	104,824
Metal Casting	116,538	11,911	10,995	20,973	6,513	19,031
Pharmaceuticals	6,586	19,088	1,576	4,425	21,311	37,214
Plastic Resins & Manmade Fibers	**16,388**	**41,771**	**2,218**	**7,546**	**67,546**	**74,138**
Textiles	8,177	34,523	2,028	9,479	43,050	27,768
Power Generation	366,208	5,986,757	140,760	464,542	13,827,511	57,384
Shipbuilding & Repair	105	862	638	943	3,051	3,967

Source: U.S. EPA Office of Air and Radiation, AIRS Database, 1997.

Table 300.6: Summary of TRI Releases and Transfers by Industry

			TRI Releases		TRI Transfers			
Industry Sector	SIC Range	# TRI Facilities	Total Releases (million lbs.)	Ave. Releases per Facility (pounds)	Total Transfers (million lbs.)	Ave. Trans. per Facility (pounds)	Total Releases + Transfers (million lbs.)	Average Releases + Transfers per Facility (pounds)
Textiles	22	339	17.8	53,000	7.0	21,000	24.8	74,000
Lumber & Wood Prod.	24	397	30.0	76,000	4.1	10,000	34.1	86,000
Furniture/Fi-xtures	25	3366	37.6	112,000	9.9	29,000	47.5	141,000
Pulp/Paper	2612-2631	305	232.6	763,000	56.5	185,000	289.1	948,000
Printing	2711-2789	262	33.9	129,000	10.4	40,000	44.3	169,000
Inorganic Chem. Mfg.	2812-2819	413	60.7	468,000	21.7	191,000	438.5	659,000
Plastic Resins/M-anmade Fibers	**2821, 2823, 2824**	**410**	**64.1**	**156,000**	**192.4**	**469,000**	**256.5**	**625,000**
Pharmaceu-ticals	2833, 2834	200	29.9	150,000	147.2	736,000	177.1	886,000
Organic Chemical Mfg.	2861-2869	402	148.3	598,000	208.6	631,000	946.8	1,229,000
Petroleum Refining	2911	180	73.8	410,000	29.2	162,000	103.0	572,000
Rubber & Misc. Plastics	30	1,947	143.1	73,000	102.6	53,000	245.7	126,000
Stone, Clay, & Concrete	32	623	43.9	70,000	31.8	51,000	75.7	121,000
Iron & Steel	331	423	90.7	214,000	513.9	1,215,000	604.6	1,429,000
Metal Casting	332, 336	654	36.0	55,000	73.9	113,000	109.9	168,000
Nonferrous Metals	333, 334	282	201.7	715,000	164	582,000	365.7	1,297,000
Fabricated Metals	34	2,676	83.5	31,000	350.5	131,000	434.0	162,000
Electronic Equip. & Comp.	36	407	4.3	11,000	68.8	169,000	73.1	180,000
Motor Vehicles, Bodies, Parts, & Accessories	371	754	79.3	105,000	194	257,000	273.3	362,000
Shipbuilding	3731	43	2.4	56,000	4.1	95,000	6.5	151,000

The 20 additional compounds are listed on page 300-75

Table 300.7: Polyester Resin Operations Rule/Measure/Date/ Performance Standards for California

Rule/Measure/Date						
Regulated Component	Pollutant	Bay Area AQMD Rule 8-50 Polyester Resin Operations Last Revised 12/20/95	Colusa APCD Rule 2-37 VOC Control Measure f/Polyester Resin Operations Last Revised 1/23/96	Sacramento AQMD Rule 465 Polyester Resin Operations Last Revised 2/6/97	Santa Barbara APCD Rule 349 Polyester Resin Operations Last Revised 4/27/93	South Coast AQMD Rule 1162 Polyester Resin Operations Last Revised 5/13/94
Performance Standard						
Compounds exempt in all rules	VOC	Carbon monoxide Carbon dioxide Carbonic acid Metallic carbides or carbonates Ammonium carbonate Methane	Carbon monoxide Carbon dioxide Carbonic acid Metallic carbides or carbonates Ammonium carbonate Methane	Carbon monoxide Carbon dioxide Carbonic acid Metallic carbides or carbonates Ammonium carbonate Methane	Carbon monoxide Carbon dioxide Carbonic acid Metallic carbides or carbonates Ammonium carbonate Methane	Carbon monoxide Carbon dioxide Carbonic acid Metallic carbides or carbonates Ammonium carbonate Methane
There are appx. 20 additional compounds exempt in the following districts, unless indicated otherwise: COLAPCD SACAQMD SBAPCD SCAQMD SDAPCD SJUAPCD YSAQMD VENAPCD	VOC	Does not exempt the 20 additional compounds, exempts: acetone, parachlorobenzotrifluoride (PCBTF), cyclic, branched or linear completely methylated siloxanes (VMS), & cetone (sic).	The 20 additional compounds.	Including the following: ethane, parachlorobenzotrifluoride (PCBTF), acetone, perchloroethylene (tetrachloroethylene), 3,3-dichloro-1,1,1,2,2pentafluoro-propane (HCFC-225ca), 1,3-dichloro-1,1,2,2,3-penta-fluoropropane(HCFC-225cb-), 1,1,1,2,3,4,4,5,5,5-decafluoropentane (HFC 43-10mee), & cyclic, branched, or linear completely methylated siloxanes	Including the following: ethane, acetone, parachlorobenzotrifluoride (PCBTF), & cyclic, branched or linear completely methylated siloxanes (VMS)	Including carbon tetrachloride
General Polyester Resin Material	VOC	<35% by weight monomer content	<35% by weight monomer content	<35% by weight monomer content	<35% by weight monomer content	<35% by weight monomer content
Resin Containing Vapor Suppressant	VOC/ROC	Weight loss from VOC Emissions <60 g/sq. m	Weight loss from VOC Emissions <60 g/sq. m	Weight loss from VOC Emissions <60 g/sq. m	Weight loss from VOC Emissions <60 g/sq. m	Weight loss from VOC Emissions <60 g/sq. m
Closed-mold System	VOC	Yes, no limit.	Yes, weight loss <4%	Yes, no limit.	Yes, no limit.	Yes, weight loss <4%
High Strength Materials	VOC	None	<48% monomer content by weight	None	None.	<48% monomer content by weight
Specialty Resins	VOC	See corrosion-resistant materials & fire retardant materials.	See high strength materials, corrosion-resistant materials & fire retardant materials.	<50% monomer content by weight	<50% monomer content by weight	See high strength materials, corrosion-resistant materials & fire retardant materials.
Corrosion-resistant Materials	VOC	<50% monomer content by weight	<50% monomer content by weight	See Specialty Resins.	See Specialty Resins.	<48% monomer content by weight
Fire Retardant Materials	VOC	<50% monomer content by weight	<42% monomer content by weight	See Specialty Resins	See Specialty Resins.	<42% monomer content by weight
Cleaning Materials	VOC	<200 g VOC/1 material Shall not use organic compounds for the clean-up of spray equipment including spray lines unless equipment f/collecting the cleaning material & minimizing their evaporation to the atmosphere is used.	When cleaning materials containing >1.7 lbs of VOC per gallon or having initial boiling point <190°C exceeds 4 gallons per day, a cleaning material reclamation system w/80% efficiency shall be used. Solvent residues f/the system shall be <20% VOC by weight.	Cleaning materials containing >1.7 lb VOC per gallon (204 gm/1), shall not be used except in enclosed gun cleaners or to clean molds, spray equipment, or other dispensing equipment tools used in gel coat or specialty resin operations, provided that the cleaning materials <4 gallons per week.	None	Use cleaning materials w/<50 grams VOC per liter (0.42 lb VOC per gallon). A person shall used closed containers or hand held spray bottles from which solvents are applied without a propellant-induced force, cleaning equipment which has a solvent container that can be & is closed during cleaning operations, & a solvent flushing method where the cleaning solvent is discharged into a container which is closed except f/solvent collection openings & the discharged solvent must be collected into containers without atomizing into the open air.
Gel Coat	VOC	<250 g VOC per 1 coating applied	See clear gel coat & pigmented gel coat.	See clear gel coat & pigmented gel coat.	See clear gel coat & pigmented gel coat.	See clear gel coat & pigmented gel coat.

Table 300.7: (cont.)

Clear Gel Coat	VOC	See gel coat	<50% monomer content by weight	<50% monomer content by weight	<50% monomer content by weight	<50% monomer content by weight
Pigmented Gel Coat	VOC	See gel coat	<45% monomer content by weight	<45% monomer content by weight	<45% monomer content by weight	<45% monomer content by weight
Alternative Emission Control Requirements (in lieu of meeting process standards)	VOC	>85% control & capture efficiency	>85% control & capture efficiency	>85% control & capture efficiency, written approval by APCO, operation under APCO approved operation & maintenance plan	>85% control & capture efficiency	>90% control & capture efficiency
Pultrusion Operations	VOC	None	Shall have covered wetout baths. From exit of the bath to the die, all but 18" of the preform distance shall be enclosed to minimize airflow (<3% weight loss).	None	None	Shall have covered wet-out baths. From exit of the bath to the die, all but 18" of the preform distance shall be enclosed to minimize airflow (<3% weight loss).
Surface Preparation	VOC	None	None	None	None	None
Spraying Operations	VOC	Use airless spray, air-assisted airless spray, electrostatic spray, high-volume/low-pressure spray.	Use airless spray, air-assisted airless spray, electrostatic spray, high-volume/low-pressure spray.	Use airless spray, air-assisted airless spray, electrostatic spray, high-volume/low-pressure spray.	Use airless spray, air-assisted airless spray, electrostatic spray, high-volume/low-pressure spray.	Use airless spray, air-assisted airless spray, electrostatic spray, high-volume/low-pressure spray. For touch-up & repair, a handheld air atomized spray gun w/a resin container as part of the gun may be used.
Resin Baths	VOC	Shall be covered	None	None	None	None
Compound Limitations	VOC	None	None	None	None	None
Monitoring & Records	VOC/ROC	Shall maintain list of polyester resins, catalyst, cleaning material, % VOC in polyester resin materials, & grams of VOC per liter f/cleaning materials. For vapor suppressed resins, maintain list of weight loss during polymerization, monomer % & gel time. Daily records of amount of polyester resin materials & cleaning materials used, volume of resin & cleaning materials used f/touch-up & repair, & hours of operation & key system operating parameters. All records shall be retained f/the previous 24 month period.	Shall maintain list of polyester resins, catalyst, cleaning material, % VOC in polyester resin materials, & grams of VOC per liter f/cleaning materials. For vapor suppressed resins, maintain list of weight loss during polymerization, monomer % & gel time. Records of amount of polyester resin materials & cleaning materials used, volume of resin & cleaning materials used f/touch-up & repair, & record of hours of operation & key system operating parameters. All records shall be retained f/the previous 24 month period.	Shall maintain records of type & quantity of all resins, catalysts, cleaning materials, filer material, pigment materials, & all additional additives used in resins as applied. Records of monomer content, in weight %, all resin materials used or stored at the facility, VOC content of all cleaning materials used & stored at the facility, & records of hours of operation & key operating parameters. For vapor suppressed resins, maintain list of weight loss during polymeriztion, & amount used. Records maintained on 1) monthly basis if total VOC emissions >5 tons/year, 2) annual basis if total VOC emissions < or equal to 5 tons/year, 3) all records shall be maintained f/a continuous 3 year period. If at any time a source uses a coating which does not comply w/the standards in Section 301, daily records regarding the use & lack of use of that non-compliant resin shall be maintained.	Shall maintain list of polyester resins, catalyst, cleaning material, % ROC in polyester resin materials, & grams of ROC per liter f/cleaning materials. For vapor suppressed resins, maintain list of weight loss during polymerization, monomer % & gel time. Records of key operating parameters f/each day of operation f/add-on control equipment. All records shall be retained f/the previous 24 month period.	Shall maintain daily records of manufacturers name, type & amount of each polyester resin, corrosion resistant, fire retardant, high strength materials & gel coats used, % weight of monomer, amount of VOC-containing materials, VOC content in grams/liter, f/vapor suppressed resins, a certificate from a resin manufacturer f/each resin type, & f/closed-mold & pultrusion operations, the % weight loss of polyester resin materials f/each application. Records of cleaning solvents subject to Rule 1171 shall be maintained pursuant to Rule 109. Maintain daily records of all key operating parameters. –
Storage	VOC/ROC	Use closed containers f/storage of all polyester resin materials, cleaning materials & any unused VOC-containing materials except when accessed f/use.	Use closed containers f/storage of all uncured polyester resin materials, cleaning materials & any unused VOC-containing materials except when accessed f/use.	Use closed containers f/storage of all polyester resin materials, cleaning materials, & any unused VOC-containing materials except when accessed f/use.	Use closed containers f/storage of all polyester resin materials, cleaning materials & any unused ROC-containing materials except when accessed f/use.	Use closed containers f/storage of all resin materials except when accessed for use.
Disposal	VOC/ROC	Shall use self-closing containers f/the disposal of all polyester resin materials, cleaning materials, waste materials, & any unused VOC containing materials.	Shall use self-closing containers f/the disposal of all uncured polyester resin materials, cleaning materials, waste materials, & any unused VOC containing materials.	Shall use closed containers f/the disposal of all uncured polyester resin materials, cleaning materials, waste materials, & any unused VOC containing materials.	Use closed containers f/disposal of all polyester resin materials, cleaning materials, & any unused ROC-containing materials except when accessed f/use.	Use closed containers f/disposal of all resin materials except when accessed f/use.

Table 300.7: (cont.)

Rule/Measure/Date						
Regulated Component	Pollutant	San Diego APCD Rule 67.12 Polyester Resin Operations Effective 5/15/96	Shasta AQMD Rule 3: 13 Polyester Resin Operations Last Revised 6/6/95	San Joaquin APCD Rule 4684 Polyester Resin Operations Adopted 5/19/94	Yolo Solano AQMD Rule 2.30 Polyester Resin Operations Last Revised 8/25/93	Ventura APCD Rule 74-14 Polyester Resin Material Operations Revised 5/26/92
Performance Standard						
Compounds exempt in all rules.	VOC	Carbon monoxide Carbon dioxide Carbonic acid Metallic carbides or carbonates Ammonium carbonate Methane	Carbon monoxide Carbon dioxide Carbonic acid Metallic carbides or carbonates Ammonium carbonate Methane	Carbon monoxide Carbon dioxide Carbonic acid Metallic carbides or carbonates Ammonium carbonate Methane	Carbon monoxide Carbon dioxide Carbonic acid Metallic carbides or carbonates Ammonium carbonate Methane	Carbon monoxide Carbon dioxide Carbonic acid Metallic carbides or carbonates Ammonium carbonate Methane
There are appx. 20 additional compounds exempt in the following districts, unless indicated otherwise: COLAPCD SACAQMD SBAPCD SCAQMD SDAPCD SJUAPCD YSAQMD VENAPCD	VOC	Including the following: perchloroethylene (tetrachloroethylene), acetone, ethane, 1-chloro-4-trifluoromethyl benzene parachlorobenzotrifluoride, PCBTF, & cyclic, branched, or linear completely methylated siloxanes (VMS).	Does not exempt the 20 additional compounds.	Including the following: ethane, acetone, parachlorobenzotrifluoride, & cyclic, branched, or linear completely methylated siloxane compounds.	The 20 additional compounds.	Including the following: cyclic, branched, or linear completely methylated siloxanes (VMS).
General Polyester Resin Material	VOC	<35% by weight monomer content	<35% by weight monomer content	<35% by weight monomer content	<35% by weight monomer content	<35% by weight monomer content
Resin Containing Vapor Suppressant	VOC	Weight loss from VOC emissions <60 g/sq. m	Weight loss from VOC emissions <60 g/sq. m	Weight loss from VOC emissions <60 g/sq. m	Weight loss from VOC emissions <60 g/sq. m	Weight loss from ROC emissions <60 g/sq. m
Closed-mold System	VOC	Yes, no limit.	Yes, no limit.	Yes, no limit.	Yes, no limit.	Yes, no limit.
High Strength Materials	VOC	None	<48% monomer content by weight	None	None	See Specialty Resins.
Specialty Resins	VOC	See corrosion-resistant materials & fire retardant materials.	<50% monomer content by weight	Use low VOC w/<50% monomer content by weight.	Use low VOC w/<50% monomer content by weight.	<50% monomer content by weight
Corrosion-resistant Materials	VOC	<50% monomer content by weight	<48% monomer content by weight	See Specialty Resins.	See Specialty Resins.	See Specialty Resins.
Fire Retardant Materials	VOC	<50% monomer content by weight	<42% monomer content by weight	See Specialty Resins.	See Specialty Resins.	See Specialty Resins.
Cleaning Materials	VOC	A VOC reclamation system shall be used unless the materials contain <1.7 lb VOC per gallon (200 gm/l), or the materials have initial boiling points >190°C or the combined usage of materials not complying w/either condition is <0.5 gallons average per operating day calculated from monthly monitoring records. Solvent residue from reclamation system shall contain < or equal to 20% VOC by weight.	When cleaning materials containing >1.7 lbs of VOC per gallon or having initial boiling point <190°C exceeds 4 gallons per day, a cleaning material reclamation system w/>80% efficiency shall be used. Solvent residues for the system shall be <20% VOC by weight.	Cleaning materials containing >1.7 lb VOC/gallon shall not be used except: 1) in – enclosed equipment cleaners; or 2) to clean molds, spray equipment or other dispensing equipment tools used in gel coat or specialty resin operations provided that the use of cleaning materials is <4 gallons per day.	When cleaning materials containing >1.7 lbs of VOC per gallon or having initial boiling point <190°C exceeds 4 gallons per day, a cleaning material reclamation system w/>80% efficiency shall be used. Solvent residues for the system shall be <20% VOC by weight.	When cleaning materials containing >1.7 lbs of ROC per gallon or having initial boiling point <190°C exceeds 15 gallons per calendar week, a reclamation system shall be used. Residues for the system shall be <20% ROC by weight.
Gel Coat	See clear gel coat & pigmented gel coat.	See clear gel coat & pigmented gel coat.	See clear gel coat & pigmented gel coat.	See clear gel coat & pigmented gel coat.	Use low VOC w/<45% monomer content by weight. (treated as pigmented gel coat due to clear gel coat standard).	See clear gel coat & pigmented gel coat.

Table 300.7: (cont.)

Performance Standard						
Clear Gel Coat	VOC	<50% monomer content by weight	<50% monomer content by weight	Use low VOC w/<50% monomer content by weight.	Use low VOC w/<50% monomer content by weight	<50% monomer content by weight
Pigmented Gel Coat	VOC	<45% monomer content by weight	<45% monomer content by weight	Use low VOC w/<45% monomer content by weight.	See Gel Coat.	<45% monomer content by weight
Alternative Emission Control Requirements (in lieu of meeting process standards)	VOC	None	>85% control & capture efficiency	>85% control & capture efficiency	>85% control & capture efficiency	>85% control & capture efficiency
Pultrusion Operations	VOC	None	None	None	None	None
Surface Preparation	VOC	Conduct all dry sanding, grinding & cutting operations of polyester resin which contains fiberglass either inside a controlled enclosure or using a controlled process. For marine vessel repair operations this requirement shall apply only for sanding, grinding or cutting operations conducted on the exterior of a vessel hull. Excludes portable drilling operations.	None	None	None	None
Spraying Operations	VOC	Use airless spray, air-assisted airless spray, electrostatic spray, high-volume/low-pressure spray. For touch-up & repair, a handheld air atomized spray gun w/a resin container as part of the gun may be used.	Use airless spray, air-assisted airless spray, electrostatic spray, high volume/low-pressure spray.	Use airless spray, air-assisted airless spray, electrostatic spray, high-volume/low-pressure spray.	Use airless spray, air-assisted airless spray, electrostatic spray, high-volume/low-pressure spray.	Use airless spray, air-assisted airless spray, electrostatic spray, high-volume/low-pressure spray. For touch-up & repair, a handheld air atomized spray gun w/a resin container of no more than one quart capacity as part of the gun may be used.
Resin Baths	VOC	None	None	None	None	None
Compound Limitations	VOC	Not use a polyester resin or cleaning material subject to this rule that, after 12/4/90, was newly formulated to contain or reformulated to increase the content of methylene chloride, CFC-11, CFC-12, CFC-113, CFC-114, or CFC-115. A person shall not sell or, offer for sale, a polyester resin or cleaning material subject to this rule that, after 12/4/90, was newly formulated to contain or reformulated to increase the content of methylene chloride, CFC-11, CFC-12, CFC-113, CFC-114, or CFC-115. A person shall not manufacture, sell, offer for sale, or supply any coating or cleaning materials for use in polyester resin operations unless polyester resin or cleaning material container displays the content of methylene chloride (CFC-11), dichlorodifluoromethane (CFC-12), trichlorotrifluoroethane (CFC-113), dichlorotetrafluoroethane (CFC-114), or chloropentafluoroethane (CFC-115).	None	None	A person shall not specify the use of any gel coat or polyester resin material subject to the provisions of this rule that does not meet the limits & requirements of this rule where such applications result in a violation of this rule. The requirements of this Section shall apply to all written or oral contracts. A person shall not sell or offer for sale any gel coat or polyester resin material subject to the provisions of this rule that does not meet the limits & requirements of this rule where such applications result in a violation of this rule.	None

Table 300.7: (cont.)

Performance Standard						
Monitoring & Records	VOC	Maintain current records of polyester resin materials & gel coats used, which provides mfr. identification, material specifications, monomer content, content of any catalysts, fillers, &/or diluents, including thinners, & type of each resin or gel coat. Also maintain records of content of methylene chloride, CFC-11, CFC-12, CFC-113, CFC-114, CFC-115 contained in any polyester resin material or cleaning material used. For vapor suppressed resins, maintain records showing mfrs. information on the weight loss during polymerization. Maintain daily records of mfrs. identification & amount of each polyester resin material & cleaning material used. Retain records f/@ least 3 years.	Shall maintain list of polyester resins, catalyst, cleaning material, % monomer in each polyester resin materials, & grams of VOC per liter f/cleaning materials. For vapor suppressed resins, maintain list of weight loss (gm/sq. m) during polymerization, monomer % & gel time. Records of amount of polyester resin materials & cleaning materials used, volume of resin & cleaning materials used for touch-up & repair, & record of hours of operation & key system operating parameters. All records shall be retained f/the previous 24 month period.	Daily records of the type & quantity of all resins, catalysts, & cleaning materials used. Records of VOC content, % weight, all polyester resin materials used or stored @ the facility, VOC content of all cleaning materials used & stored @ the facility, hours of operation, & key operating parameters f/any add-on control equipment. For vapor suprpessed resins maintain list of weight loss (gm/sq. m) during polymerization. All records shall be retained for the previous 24 month period.	Shall maintain list of polyester resins, catalyst, cleaning material, % VOC in polyester resin materials, & grams of VOC per liter f/cleaning materials. For vapor suppressed resins, maintain list of weight loss during polymerization, monomer % & gel time. Daily records of amount of polyester resin materials & cleaning materials used, volume of resin & cleaning materials used f/touch-up & repair, & hours of operation & key system operating parameters. All records shall be retained f/the previous 24 month period.	Weekly reports of the mfr. & product number of each polyester resin material & cleaning material used, amount of cleaning material both used & reclaimed or recycled, & the application method for each polyester resin & cleaning material used. Records of emission rate of each polyester resin material used, as either the ROC loss rate in grams/sq. m or as % monomer content, gel time, & ROC content in lb ROC per gallon of cleaning material. Daily reports of control efficiency monitoring information, & the quantity & type of polyester resin material used. All records shall be retained f/the previous 24 month period.
Storage	VOC	Use self-closing containers f/all polyester resin, VOC containing materials & solvent-laden rags including waste materials except when accessed f/use.	Use closed containers f/storage of all uncured polyester resin materials, cleaning materials & any unused VOC containing materials except when accessed f/use.	Use closed containers f/storage of all polyester resin materials, cleaning materials or other VOC containing materials except when accessed f/use.	Use closed containers f/storage of all polyester resin materials, cleaning materials & any unused VOC containing materials except when accessed f/use.	Use closed containers f/storage of all materials containing reactive organic compounds, used or unused, including but not limited to semi-solid or liquid polyester resin materials & solid or liquid cleaning materials.
Disposal	VOC	See storage.	Use self-closing containers f/the disposal of all uncured polyester resin materials, cleaning materials, waste materials, & any unused VOC containing materials.	Use self-closing containers f/the disposal of all uncured polyester resin materials, cleaning materials, or any unused VOC containing materials.	Use self-closing containers f/the disposal of all polyester resin materials, cleaning materials, waste materials, & any unused VOC containing materials.	See storage.
Rule/Measure/Date						
Regulated Component	Pollutant	Determination of RACT/BARCT f/Polyester Resin Operations CARB 1/8/91.				
Performance Standard						
Compounds exempt in all rules.	VOC	Carbon monoxide Carbon dioxide Carbonic acid Metallic carbides or carbonates Ammonium carbonate Methane				

Table 300.7: (cont.)

Performance Standard						
There are appx. 20 additional compounds exempt in the following districts, unelss indicated otherwise: COLAPCD SACAQMD SBAPCD SCAQMD SDAPCD SJUAPCD YSAPCD VENAPCD		Some of the 20 compounds are not exempt, which includes the following: 2-chloro-1,1,1,2-tetrafluoro-ethane (HCFC-124), 1,1,1-trifluoroethane(HFC-143a), 1,1-difluoroethane (HFC-152a), & saturated perfluorocarbons containing sulfur w/sulfur bonds only to carbon & fluorine cyclic, branched, or linear completely fluorinated alkanes, ethers w/no unsaturations, & tertiary amines w/no unsaturations.				
General Polyester Resin Material	VOC	<35% by weight monomer content				
Resin Containing Vapor Suppressant	VOC	Weight loss from VOC emissions <60 g/sq. m				
Closed-mold System	VOC	Yes, no limit.				
High Strength Materials	VOC	See Specialty Resins.				
Specialty Resins	VOC	<50% monomer content by weight				
Corrosion-resistant Materials	VOC	See Specialty Resins.				
Fire Retardant Materials	VOC	See Specialty Resins.				
Cleaning Materials	VOC	When cleaning materials containing >1.7 lbs of VOC per gallon or having initial boiling point <190°C exceeds 4 gallons per day, a cleaning material reclamation system w/>80% efficiency shall be used. Solvent residues for the system shall be <20% VOC by weight.				
Gel Coat	VOC	See clear gel coat & pigmented gel coat.				
Clear Gel Coat	VOC	<50% monomer content by weight				
Pigmented Gel Coat	VOC	<45% monomer content by weight				
Alternative Emission Control Requirements (in lieu of meeting process standards)	VOC	>85% control & capture efficiency				
Pultrusion Operations	VOC	None				
Surface Preparation	VOC	None				
Spraying Operations	VOC	Use airless spray, air-assisted airless spray, electrostatic spray, high-volume/low pressure spray.				
Resin Baths	VOC	None				

Table 300.7: (cont.)

Performance Standard					
Compound Limitations	VOC	None			
Monitoring & Records	VOC	Shall maintain list of polyester resins, catalyst, cleaning material, % VOC in polyester resin materials, & grams of VOC per liter f/cleaning materials. For vapor suppressed resins, maintain list of weight loss during polymerization, monomer % & gel time. Daily records of amount of polyester resin materials & cleaning materuals used, & volume of resin & cleaning materials used f/touch-up & repair. Retain all records for the previous 24 month period.			
Storage	VOC	Use closed containers to store all polyester resin materials, cleaning materials, & any unused VOC containing materials, & scrap materials resulting from cutting & grinding of freshly cured resins except when accessed for use.			
Disposal	VOC	Use self-closing containers for disposal of all uncured polyester resin materials, cleaning materials, waste materials, & any unused VOC-containing materials.			
Rule/Measure					
Rule/Measure	**BAAQMD** Rule 8-50 Polyester Resin Operations Last Reviseed 12/20/95	**Colusa APCD** Rule 2-37 VOC Control Measure for Polyester Resin Operations Last Revised 1/23/96	**SACAQMD** Rule 465 Polyester Resin Operations Last Revised 2/6/97	**SBAPCD** Rule 349 Polyester Resin Operations Last Revised 4/27/93	**SCAQMD** Rule 1162 Polyester Resin Operations Last Revised 5/13/94
Exemptions	Touch-up & repair are exempt from process requirements of 8-50-301.	Touch-up & repair are exempt from process requirements of Section 3.	Only recordkeeping requirements apply when the volume of polyester resin materials used is <20 gallons/month.	Addition or use of styrene provided that <50 gallons/calendar year is used. However, must maintain records of total styrene used per calendar year.	None
Applicability	Manufacturing of products using polyester resins.	All commercial, military, & industrial sources performing polyester resin operations.	Persons who operate polyester resin operations within Sacramento County.	All commerical & industrial polyester resin operations.	All polyester resin operations that fabricate, rework, repair, or touch-up products f/commercial, military, or industrial use.
Comments		Has the same compound exemptions as Yolo-Solano 2.30.		This rule applies to ROC, which in the comparisons was assumed to be equivalent to VOC. Has the same compound exemptions as San Joaquin 4684.	

Table 300.7: (cont.)

Rule/Measure/Date					
Rule/Measure	SDAPCD Rule 67.12 Polyester Resin Operations Effective 5/15/96	SHAAQMD Rule 3: 13 Polyester Resin Operations Last Revised 6/6/95	SJUAPCD Rule 4684 Polyester Resin Operations Adopted 5/19/94	YSAQMD Rule 2.30 Polyester Resin Operations Last Revised 8/25/93	VENAPCD Rule 74-14 Polyester Resin Material Operations Revised 5/26/92
Exemptions	Any polyester resin operations where the combined consumption of polyester resins, including corrosion resistant resin, fire retardant resin, gel coat, & cleaning materials is <1 gallon/operating day. Any marine vessel repair operations where the combined consumption of polyester resins, including corrosion resistant resin, fire retardant resin, gel coat, & cleaning materials is <0.5 gallon/operating day. Any coating subject to Rules 67.3, 67.0, or 67.11.	Touch-up & repair are exempt from Section 300 Standards.	The provisions of this rule, other than the recordkeeping requirements of Section 6.1, shall not apply to any polyester resin operation provided the volume of polyester resin materials used is less than 20 gallons/month.	The provisions of Section 300 Standards shall not apply to touch-up & repair.	Any polyester resin operations subject to the requirements of this Rule shall be exempt from the requirements of Rule 66, w/the exception of Rule 66.A.7. The provisions of Section B Requirements of this rule shall not apply to stationary sources using less than 20 gallons/month of polyester resin material.
Applicability	Polyester Resin Operations	All commercial & industrial stationary sources performing polyester resin operations.	All commerical & industrial polyester resin operations.	All commercial & industrial stationary sources performing polyester resin operations.	Manufacture of products from or the use of polyester resin material.
Comments		Has the least amount of compound exemptions.	Has the same compound exemptions as Santa Barbara 349.	Has the same compound exemptions as Colusa 2-37.	This rule applies to ROC, which in the comparisons was assumed to be equivalent to VOC.
Rule/Measure	Determination of RACT/BARCT f/Polyester Resin Operations CARB 1/8/91.				
Exemptions	Touch-Up & repair are exempt from meeting the Standards.				
Applicability	Commercial & industrial polyester resin operations.				
Comments					

400 INSPECTIONS

Polyester Resin/ Fiberglass

Conducting Inspections

How to do an Inspection. This chapter, written primarily for the regulatory inspector, can be a source of information for conducting facility self-inspections. It can guide you through a complete compliance inspection of a polyester resin/ fiberglass facility. It discusses procedures for pre-inspection, post inspection, sampling, and inspector safety. Guidelines and checklist materials are provided here. **When you use your checklists,** you may find rewards. Your inspections will be more effective, and **you will save time** as you are more aware of these aspects of your inspection:

* What to look for;
* What questions to ask;
* How to locate unpermitted solvent equipment; and,
* How to conduct, complete, and document your inspection.

The standards and policies you need to determine compliance with each requirement will depend on your specific district rules and implementation strategy. You may place a copy of your district rules and your inspection aids in the appendix provided for it. The index can help you find the section and page number for additional information on specific issues.

Types of Operation Process Materials

Types of Operations in Polyester Resin Fiberglass facilities are discussed at length on pages **300-1 to 300-39. Spray Guns** are discussed at length on pages **300-7 to 300-19. Process Materials** in Polyester Resin Fiberglass facilities are discussed at length on pages **300-39 to 300-51.**

California Standard

In addition, **all Rules, Measures, and Dates for Performance Standards for Polyester Resin Fiberglass facilities throughout California** are discussed at length on pages **300-70 to 300-77.**

Pre-Inspection

First, follow the pre-inspection procedures. Review the source files and applicable rules, learn what equipment you may need, what information to exchange with the facility manager, and what to check for on the Permit to Operate.

Then, proceed with a complete compliance inspection, including solvent equipment, operations, and administrative requirements.

Finally, the post-inspection procedures provide guidance on how to determine compliance rates, calculate excess emissions, and assure follow-up.

400 INSPECTIONS

401 PRE-INSPECTION PROCEDURES

The objective of an inspection is to determine a facility's compliance with district regulations and Permits to Operate. It is essential to prepare for the inspection prior to visiting the site. Here are some guidelines, listing steps to follow prior to the inspection.

401.1 FILE REVIEW

File Review

Before the site inspection, review all information available in the district source files including:

1. Processes involved at the facility;
2. Source tests and emissions inventory;
3. Alternative emissions control plans;
4. Equipment lists;
5. Permit applications;
6. Permits approved;
7. Conditions for each permitted unit;
8. Previous inspection reports;
9. Reports of violations (note rule sections and equipment);
10. Enforcement action taken;
11. Complaints;
12. Variance history;
13. Abatement orders; and,
14. Breakdown reports.

401.2 REGULATION REVIEW

Regulation Review

Review any references to specific rules which are noted in the source files. Study and understand each standard and exemption in pertinent rules, bearing in mind that you may be asked to explain them. To clear up any confusion, discuss the requirements with experienced personnel to assure that there is a consistent interpretation of these requirements and how they are to be applied.

401.3 INSPECTION FORM

Inspection Forms

Since most district solvent rules specify their own requirements for operations, equipment, and administration, you will want to use your district's inspection form. In designing an inspection form, it is helpful to solicit a response for each requirement and exemption, and you may wish to limit the length of the form to one page, using both sides. To save time during the pre-inspection meeting, you may wish to complete some portions of the inspection document before the inspection. There is a sample inspection form at the end of this chapter.

401.4 EQUIPMENT CHECK

Checking Equipment

Assemble all of the appropriate equipment to conduct your inspection. Consider the items you may need in order to protect yourself, to determine compliance, to calculate excess emissions, and to complete the inspection efficiently. Here are some of the items you may need:

* Vision and hearing protection, safety shoes, hard hat, and gloves;
* Identification cards and business cards;
* Forms for inspection and chain of custody;
* Sampling supplies, if samples are required: cans, labels, pens, seals, wipes, and container to carry cans;
* Specialized equipment such as a visible emissions evaluation kit, with provisions for determining temperature, dewpoint, and wind; and,
* Tape measure, camera, and film. A word of caution: **always obtain permission to take any photographs at the facility you are inspecting**. If you are in a particularly small area and there are solvents present, you could accidentally set off a spark if the solvent drums are not grounded to protect them from any static or other sources of electricity, sparks, etc.

401.5 PRE-ENTRY AND ENTRY

Entry

1. Upon arrival at the facility, smell the air and take an overall view:

   * Do you smell any solvent vapors or other odors inside or outside?
   * Do you see any emissions?
   * Note the size and layout of the facility.
   * Identify and prioritize potential problem areas to inspect first, in case your time runs short.

2. Enter the facility through the normal public access.
3. Present your business credentials.
4. Request to see the contact person mentioned in the files, such as the company president, or a supervisor of environment, production, or maintenance.

Be prepared to cite and provide copies of these sections of the California Health & Safety Code (HSC) in case the source representative may not be familiar with your district's authority:

* 41510: Right of Entry; and,
* 42303: Information Required.

Know your district's policy for refused entry.

401.6 PRE-INSPECTION MEETING

Pre-Inspection Meetings

Before you begin your inspection, meet with the source operator, manager, or their representative to discuss the details which either of you may need to know before you conduct your inspection.

1. Introduce yourself to the manager. This would be a good time to exchange business cards.

   * Tell the manager that you intend to conduct a compliance inspection of the solvent cleaning/PRF equipment at the facility.
   * Discuss any unfinished district business, such as variances, Authority to Construct, and any prior compliance problems.
   * Tell the manager that you will need some assistance from him/her concerning the inspection and that you will brief him/her on your findings when the inspection is completed.
   * Obtain facility information, including:
     1. Name and ownership of the facility.
     2. Address of the facility.
     3. Name and title of the contact person.
     4. Phone number with area code.
   * Record the date and time of the inspection.
   * Discuss sample collection if appropriate, and request copies you need, such as inventory reports or material safety data sheets (MSDS).
   * Discuss safety procedures.

Records Review

2. Review your district records with the facility manager to reconcile the number, type, and location of PRF equipment at the facility. Obtain current operating information about each one, and if any equipment is reported to be in storage, then make a note to assure, during the inspection, that it is in fact inoperative.
3. Be sure to specifically ask the facility manager about any small cold cleaners. Some facility managers may not be aware that these types of cleaners may be subject to solvent rules.

4. Review the facility solvent usage records as specified in your district's rules. This information will be useful to your emissions inventory efforts, and could be used in an alternative method for determining excess emissions. Be sure to record the exact type of solvent used in each instance.

402 FACILITY INSPECTION PROCEDURES

A thorough annual inspection should include the following parameters:

Inspection Procedures

1. **A REVIEW OF THE SOURCE FILE TO MAKE THE INSPECTOR FAMILIAR WITH:**

a. The type of operation to be evaluated;
b. The type of equipment to be inspected (make, model, size, capacity, location, etc.) and applicable permits;
c. The type and number of emission points to be inspected;
d. The specific type of emissions that are emitted by the plant;
e. The district, State, and federal regulations that apply to the source; and,
f. The plant history -- i.e., complaints, enforcement actions, variances, source tests, etc.

2. **A SITE INSPECTION WHICH INCLUDES AT A MINIMUM, THE FOLLOWING:**

a. An interview with the plant management concerning working hours, number of employees, production rates, raw and finished materials, equipment problems, equipment modifications;
b. A review of all permits to operate at the facility;
c. A review of progress on any current variance or abatement order;
d. Verification that all permit conditions are being complied with;

Inspection Procedures

e. Determination whether any equipment has been installed or modified without an authority to construct and/or permit to operate being issued;
f. A review of all maintenance records for problem areas which could affect emissions;
g. Inspection and documentation of the operating condition of the entire source system, including the:

1. Systems Entrance (point of contaminant generation).
2. Transport (duct work).
3. Air Mover (fan).
4. Instrumentation (controls and monitors).
5. Sub systems (contaminant removal and feed materials).
6. Air Pollution Control Equipment.

h. Observation of the operation of in-stack monitors, if applicable; and,
i. Observation and documentation of emissions from all emission points.

3. <u>**PREPARATION OF A DETAILED REPORT FOR THE DISTRICT FILES WHICH INCLUDES:**</u>

a. A written description of the source and process(es);
b. A plot plan showing equipment location and all emission points;
c. A process flow diagram (materials handled, flow rates, temperatures, pressures, etc.);
d. A statement as to whether each emission point is in compliance or in violation;
e. A recommendation, if appropriate, that a source test be conducted or an engineering evaluation be completed for all emission points that are regulated by rules other than the opacity rule;
f. Assessment of fugitive emissions, nuisance potentials and other potential impacts of the source.

The inspector may also include in this report any first-hand knowledge that he or she has concerning the use of Reasonably Available Control Technology and Best Available Retrofit Control Technologies at similar facilities (RACT/BARCT).

Please refer to the chapter on RACT/BARCT for Polyester Resin/Fiberglass Operations on pages 700-1 through 700-14 for further information.

400 INSPECTIONS

Inspection Procedures

Ask yourself questions about each aspect of the facility which will help you to determine compliance with your district's regulations and permit conditions. Most districts have developed inspection forms tailored for their own regulations and permit conditions. Write the answers on the form.

If your district does not have a tailored inspection form, the questions in the following sections may help you to develop a source-specific inspection form pertinent to the regulations and permit conditions for facilities in your district.

Compliance and Regulations. Check compliance with the regulations associated with solvent/PRF facilities, including the requirements for toxics.

Begin the inspection by checking the Permits to Operate for each permitted item and also for additional potential unpermitted equipment. Verify that the equipment operates in accordance with the permit conditions and district regulations. Most district regulations also include emission reduction requirements, solvent storage and disposal requirements, facility exemptions, and record keeping; consider all of these aspects.

A current Permit to Operate must be posted on or near the equipment. Determine whether the equipment has been altered since the Permit was last issued. If the equipment has been modified, check to see that an Authority to Construct was granted. A Notice of Violation is appropriate if the permit procedures were not followed or if the source is not in compliance with district permit conditions. Many districts also require operating practices to be posted.

There may be special VOC requirements for your district for hand-wiping rules. Be sure to check with your local district for specific rules regarding this. **Please see pages 300-70 to 300-77 for your specific local district rules.**

When conducting an inspection be sure to note the following:

1. That the source's permit is current (paid up) and if it is properly posted.

2. Check to see if there are any open containers in the work area. All solvents, materials containing solvents and other materials containing organic compounds shall be stored in closed containers in accordance with your local district rules. Self-closing

Inspection Procedures

containers shall be used for storing, except during the transfer of resin or solvent, all polyester resin, VOC containing cleaning materials and solvent-laden rags, including waste materials.

3. Check to see if the proper application equipment is being used. Be sure you record the brand name, model number, and whether it was observed in use. All equipment shall be operated and maintained in accordance with the manufacturer's instructions, except as otherwise specified by the district.

4. Check to see if the <60 gm. VOC/meter exposed surface area is being complied with for vapor suppressed resin operations. Will you take a sample for lab analysis or will you rely on a MSDS or product technical bulletin from the resin supplier?

5. Check to see what rule is covered when painting of a final molded product occurs on-site.

6. Check for compliance with the monomer content requirements in PRF as applied. These standards for the South Coast Air Quality Management District in California are:

General Purpose Polyester Resin:	35% by weight
Corrosion-resistant:	48% by weight
Fire Retardant	42% by weight
High Strength	48% by weight
Clear Gel Coat	50% by weight
Pigmented Gel Coat	45% by weight

Please see page 700-2 regarding the RACT/BARCT standards for further details on process and control requirements for monomers.

7. Check to see if you need to pull a sample for lab analysis or if a MSDS product technical bulletin can be relied upon for this information. The permittee shall keep daily records of the usage of solvent and VOC content information of materials containing solvents and other materials emitting organic compounds and the quantity and method of disposal of any waste containing these substances. The

records shall be made available to the local district upon request. These records shall be maintained on-site and kept for at least three years.

8. When determining compliance for the weight loss of polyester resin from closed mold operations (4%) and pultrusion operations (3%) you should check both the source's records **and** pull a sample for lab analysis. Current MSDS or manufacturer's specifications regarding VOC content shall be maintained on-site and made readily available to the district upon request for all materials used containing organic solvents. The district shall be notified of any proposed changes in the brands or proposed increases in usage of organic solvents or other materials emitting organic compounds.

9. Check to see that the cleaning operation uses acetone or equivalent non-toxic, non-VOC compounds.

10. Check to see that the permittee has available on site pressure gauge(s) in proper operating condition to measure the air cap pressure of coating application equipment. The permittee shall maintain a permanent air pressure at the air cap in the range of 0.1 to 10 psig. This condition applies only to those operations which claim the use of high volume low pressure (HVLP) application equipment to comply with local district rules. **Please refer to pages 300-7 through 300-18 for further information regarding spray-up operations.**

11. Check to see that the removal and cleaning of the filters and screens, and the disposal of the dust, shall be done in a careful manner to minimize dust emissions to the atmosphere. Check to see that the fiberglass filters shall be cleaned as often as necessary to prevent dust emissions to the atmosphere.

12. Check to see that spray booths are not operated unless all exhaust air passes through filter media at the proper thickness ratio (check your local district rule). Make sure the organic solvents and/or coatings containing organic solvents used in this booth are clearly labeled as non-photochemically reactive by the supplier(s) or, for bulk shipments, shown to be non-photochemically reactive on bills of lading or invoices.

400 INSPECTIONS

402.1 SOLVENT WASTE HANDLING

Solvent Wastes

Solvent wastes contain at least trace amounts of the soiled materials they have cleaned, possibly including toxic agents. Classified as hazardous waste, spent solvent is subject to handling requirements, including storing, manifesting, transporting, and labeling. Storage is usually limited to 90 days unless the facility has a Toxics Storage Disposal Facility (TSDF) permit from U.S. EPA.

402.2 MAINTENANCE/MATERIAL LOGS

Maintenance/ Material Logs

Permit conditions may require records of maintenance performed. These records must be retained for specified periods of time, typically three years, and they must be made available to the air pollution control district upon request. (See number 7 listed on previous page.)

Permittee shall maintain a current list of all polyester resin materials and gel coats used, which provides the manufacturer's identification, material specifications, monomer content, content of any catalysts, fillers and or diluents, including thinner, and type of each resin (i.e., regular, vapor-suppressed, corrosion-resistant, or fire retardant) or gel coat (i.e., pigmented or clear.)

402.3 MANUALS FOR OPERATION AND MAINTENANCE

Operation & Maintenance

Some Permits require operators to obtain and be familiar with an Operations and Maintenance Manual (O&M) prepared specifically for their facility. The manufacturer may have prepared most of this information. These manuals typically include:

* General information about the facility design and equipment.
* Plans describing procedures and operating parameters.
* Plans describing preventive maintenance schedules, inspection and repair programs, and the recommended spare parts inventory.
* Emergency procedures for fires, gas leaks, power losses, waste spills, etc.
* MSDS information.

Many permits require that the equipment be operated in accordance with the manufacturer's instructions, unless the instructions conflict with district rules or permit conditions. The manufacturer instructions and procedures, along with the Operating Permit, typically must be posted on the control panel or other equipment, and be readily visible or available to the operator.

403 NEW SOURCE REVIEW

New Source Review (NSR)

In both attainment and nonattainment areas, whenever new plants are built or emissions from existing sources increase as a result of expansion, a New Source Review (NSR) is triggered. Each air pollution control district has its own NSR rule which is based on the attainment and nonattainment area criteria listed below. It is suggested that the reader refer to his/her district rule to determine all requirements that may apply to a given area. **Please refer to pages 300-70 - 300-77 for your local district rules.**

PSD

Special rules apply in attainment areas. These are called Prevention of Significant Deterioration (PSD) requirements and include the following:

BACT

* Installation of Best Available Control Technology (BACT). EPA determines BACT requirements by: (1) identifying all control technologies; (2) eliminating technically infeasible options; (3) ranking remaining control effectiveness; (4) evaluating the most effective controls and documenting results; and (5) selecting BACT;

* A detailed air quality analysis showing that there will be no violation of PSD "increments";

* Prediction of future attainment of air quality standards; and,

* Possible monitoring of air quality for one year prior to the issuance of the permit.

NSR

Restrictions in nonattainment areas are more severe. The principal requirements of NSR in nonattainment areas are:

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LAER

SIP

* Installation of Lowest Achievable Emission Rate (LAER) technology. LAER is the most stringent emission limitation derived from either of the following: (1) the most stringent emission limitation contained in any State Implementation Plan (SIP) for such class or category of source; or (2) the most stringent emission limitation achieved in practice by such class or category of source.

* Provision for "offsets" representing emission reductions that must be made by other sources and,

* Demonstration of standard attainment through the undertaking of an air quality analysis.

PSD/NAA

The PSD and NAA (nonattainment area) requirements are pollutant-specific. For example, although a facility may emit many air pollutants, only one or a few may be subject to the PSD or NAA permit requirements, depending on the magnitude of the emissions of each pollutant. Also, a source may have to obtain both PSD and NAA permits if the source is in an area which is designated nonattainment for one or more of the pollutants.

404 POST-INSPECTION PROCEDURES

Post-Inspection

Do not conclude the inspection until you have obtained all the information needed to make a compliance determination, calculate excess emissions, and document violations unless other arrangements are made or you have been asked to leave. If you are asked to leave, follow your district's policy.

Once all the information has been gathered, confer with the facility manager on your findings. Make your compliance determinations, calculate excess emissions, and issue all necessary violation notices, warnings, compliments, etc. Follow up on all violations in accordance with your district's policy to assure that the source is brought into compliance.

405 SAMPLING TECHNIQUES

Sampling Techniques

Normally, no samples are necessary to determine compliance with the solvent cleaning rules. However, in those cases where you need to determine the exact solvent used, the vapor pressure of the solvent, or the percent solvent in distilled waste, samples may be necessary.

Sampling Techniques

It is very important that your samples are collected and preserved in accordance with acceptable procedures. ASTM Method D4057-81, Manual Sampling of Petroleum and Petroleum Products, specifies many sampling techniques. It can help you assure that your samples are admissible evidence.

It is important that you use the proper techniques for sampling. We suggest that your district take the time to adopt sampling techniques for PRF operations based on those acceptable procedures. Your district techniques should address the sampling container, sampling method, and preservation of the samples.

406 LABORATORY TEST METHODS

Test Methods

Solvent properties are usually known based on suppliers' specifications and/or handbook data. The identity of many solvents is fairly evident from characteristic odors, appearance, or other properties such as density, which can be checked in the field with a hydrometer. Samples are usually taken and analyzed only as a routine check performed at intervals, or else to verify and document a suspected violation based on some other evidence.

Laboratory test methods are usually specified in applicable district rules, and the laboratory methods used to analyze any sample should conform to such specifications. If test methods are not specified in an applicable rule, appropriate standard test methods from ASTM, EPA or ARB may be used.

One of these test methods, ASTM E-260, "Practice for Packed Column Gas Chromatography," is frequently specified for determining the composition of solvent mixtures. This analysis can be used to calculate the vapor pressure of the material if permitted by applicable rules.

Another test method uses a self-contained apparatus called an isoteniscope. ASTM D2879, "Test Method for Vapor Pressure - Temperature Relationship and Initial Decomposition Temperature of Liquids by Isoteniscope," is often specified for direct measurement of vapor pressure. However, such measurements may need to be corrected for the presence of water and organic compounds defined as exempt by applicable regulations.

To obtain information/tests, you may contact ASTM at ***www.astm.org*** on the web, or at the American Society for Testing & Materials, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania, 19428-2959.

Submitting Samples

For quantifying VOC in solvent recovery residues, ARB Method 401, "Determination of the Weight Percent of Volatile Organic Compounds in Waste Products," is frequently specified. It uses gas chromatography in a gravitational purge and trap method.

Operators and district personnel should be familiar with regulatory requirements applicable to the aspects of operation which may be measured by laboratory analyses, and industry operators should be able to control their practice and the materials they use to routinely achieve compliance. A good understanding of regulations and good control of operations will make bad news from lab testing both infrequent and unlikely.

Why would you want to determine the percent solvent/VOC? Here is an example: 1,1,1 trichloroethane, or "TCA," is currently an exempt compound. It is usually mixed with stabilizers which contain VOCs. However, some districts may intend to disallow the use of exempt trike by placing a limit of 5 percent or 10 percent on the total VOC content of a cleaning agent.

When you submit your samples to the laboratory, clearly specify to the lab technician what tests are needed and in what units the results should be expressed. The Technical Review Group (TRG), comprised of representatives from local Air Pollution Control Districts (APCDs), the ARB, and the U.S. EPA, may recommend standardized test methods for low vapor pressure solvents and solvent residues.

Please refer to page 700-3 for RACT/BARCT test methods.

407 SOURCE TESTING

Source Testing

Source testing is the most sure way of ascertaining the compliance status of a stationary source because it physically measures emissions.

Source testing can provide useful information to both the regulatory agency requiring the test(s) and the regulated source. For the regulatory agency, the test results provide the necessary data to evaluate compliance with regulations and emission limits. This is the most common use of source tests and their results, although several other uses can be made of the results which, on their own could justify performing the tests.

Source Testing

A summary of source tests of a number of like sources can also be of use to the regulatory agencies in formulating control strategies and evaluating and developing regulations.

Source tests can be valuable for the industrial source being tested. From the regulated industry's standpoint the results of source testing primarily are used to verify their compliance status with local, state, and federal air pollution regulations. The tests are a tool to point to if inspectors ask about the emissions from a facility.

The results can provide a solid reference between process operation and air pollutant emissions. Engineering calculations and models may be able to predict emissions, but the test provides a solid foundation to verify the models. When predictive monitoring is to be used rather than placing a continuous emission monitor (CEM) on the stack, source tests are required to calibrate and validate the modeling to be used. The models and calculations can then be used with more confidence to determine future compliance.

The test results can also be used by the source to improve their process operation. For example, the results can provide information on the efficiency of the process in terms of raw material usage or energy efficiency. In some cases the test results can pinpoint operations that are wasting materials or venting unnecessarily to the atmosphere. Often a test can provide energy use information that can be used to fine tune a combustion process.

Source test results can also be useful to the source in designing new facilities or modifying existing facilities. The results can provide information on control device efficiency and possible ways to improve air pollutant emission control at lower cost for new and modified sources. The results can also be useful when designing process units to improve process operation and efficiency.

Health & Safety Codes

There are a wide variety of rules that allow and encourage agency presence at a source test or for the agency to require a source test. In California, a number of provisions for testing are contained in the Health and Safety Code. These provisions include:

41510

41510. Inspection and right of entry; includes inspection of the source and records and collecting emission samples.

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41511

41511. The Air Resources Board (ARB) or districts can require the owner or operator of an air pollution source to conduct source tests.

42301

42301. The district must be satisfied that a source will be in compliance and will not prevent or interfere with the attainment or maintenance of air quality standards before a permit can be issued. A source test is valuable in this determination.

42301.1

42301.1. Allows temporary operation of a new or modified unit while source testing is being conducted.

42303

42303. A district's Air Pollution Control Officer (APCO) can require emission information when needed.

42700-42708

The ARB's 'Criteria for Assessing District Enforcement and Permitting Program Adequacy' also requires that the districts incorporate source testing into their permits and programs. In a related issue, Chapter 5 of the Health and Safety Code (**42700 - 42708**) discussed requirements for continuous emission monitoring.

NSPS

NESHAPS

Federal New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAPS) provisions require an initial source test and allow for source tests at other times as necessary (40CFR60.8a; 40CFR61.13a&b). Provisions of NSPS and NESHAPS also require that sufficient notice be given so that an observer may be present.

Source performance tests can be viewed as part of an enforcement cycle in which 1) the facility is reviewed for proper design prior to construction and at the onset of operation; 2) an initial performance test is conducted; 3) periodic facility inspections are conducted; and, 4) annual or periodic source tests are required to determine continued compliance.

Sample Polyester Resin/Fiberglass Facility Inspection Form

General Information:

ARB Inspector's Name: ______________________________
Date/Time: ________________

District: ______________________________
District Inspector's Name: ______________________________

Facility Name: ______________________________
Address: ______________________________
Phone: ________________

Company Representative: ______________________________
Title: ________________

Principal Products: ______________________________
Last Inspected: ________________

Permit No.(s): ______________________________
Operating (Yes/No): ____________

Application Type Information:

HVLP: ________________
Electrostatic: ________________
Hand Application Methods: ______________________________
Airless Spray: ________________
Air-Assisted Airless: ____________
Air-Atomized Spray: ____________

Monomer Content Requirement: ______________________

Other Emission-related Information:
Closed Container Status: ______________________________
General Polyester Resin Material Compliance Status: ____________

____

400 INSPECTIONS

Resin Containing Vapor Suppressant: ____________________
Closed-mold System: ____________________
High Strength Materials: ____________________
Specialty Resins: ____________________
Corrosion-resistant Materials: ____________________
Fire Retardant Materials: ____________________
Cleaning Materials: ____________________

Gel Coats: ____________________
Clear Gel Coat: ____________
Pigmented Gel Coat: ____________

Alternative Emission Control Requirements (in lieu of meeting process standards: ____________________

Pultrusion Operations: ____________________
Surface Preparation: ____________________
Resin Baths: ____________________
Compound Limitations: ____________________

Monitoring & Records: ____________________
____

Storage: ____________________
Disposal: ____________________

Exemption Status:

None Claimed: __________ Exemption Claimed: __________
Section of Rule: ____________

Comments: ____________________
____
____
____
____
____
____
____

Other Observations:

Improperly Stored Cloths: ________
Unpermitted Equipment: ________________________________
Improper Disposal: ____________________________________
Open Containers: ______________________________________
Dirty Filters: __________________
Noncomplying Inventory: ________________________________
____

Table 400.1: Violations

VIOLATIONS					
Permit #	**Violation**	**ER/NER**	**Rule #**	**NOV #**	**N/C #**

Number of Emission-related (ER) Violations: __________________

Number of Non-emission-related (NER) Violations: _____________

Total Number of Violations: _______

500 POLLUTION PREVENTION

The best way to reduce pollution is to prevent it in the first place. Some companies have creatively implemented pollution prevention techniques that improve efficiency and increase profits while at the same time minimizing environmental impacts. This can be done in many ways such as reducing material inputs, re-engineering processes to reuse by-products, improving management practices, and substituting benign chemicals for toxic ones. Some smaller facilities are able to get below regulatory thresholds by reducing pollutant releases through simple pollution prevention policies.

Pollution Prevention Act

The Pollution Prevention Act of 1990 established a national policy of managing waste through source reduction, which means preventing the generation of waste. The Pollution Prevention Act also established, as national policy, a hierarchy of waste management options for situations in which source reduction cannot be implemented. In the waste management hierarchy, if source reduction is not feasible the next alternative is recycling of wastes, followed by energy recovery, waste treatment, and disposal as a last alternative.

In order to encourage these approaches, this section provides both general and company-specific descriptions of some pollution prevention advances that have been implemented within the plastic resin and synthetic fiber industries and the chemical industry as a whole. While the list is not exhaustive, it does provide core information that can be used as the starting point for facilities interested in starting their own pollution prevention projects. This section provides information from real activities that can, or are being implemented by this sector - including a discussion of associated costs, time frames, and expected rates of return.

This section provides summary information from activities that may be, or are being implemented by this sector. When possible, information is provided that gives the context in which the technique can be effectively used. Please note that the activities described in this section do not necessarily apply to all facilities that fall within this sector. Facility-specific conditions must be carefully considered when pollution prevention options are evaluated, and the full impacts of the change must examine how each option affects air, land, and water pollutant releases.

500 POLLUTION PREVENTION

501 SUBSTITUTE RAW MATERIALS

Raw Materials

The substitution or elimination of some of the raw materials used in the manufacturing of plastic resins and synthetic fibers can result in substantial waste reductions and cost savings. Raw materials can be substituted with less water soluble materials to reduce water contamination and less volatile materials to reduce fugitive emissions. Sometimes certain raw materials can be eliminated all together. The need for raw materials that end up as wastes should be reexamined to determine if raw materials can be eliminated by modifying the process and improving process control.

* A specialty batch polymer plant in the Northeast avoids highly toxic and hazardous substances in the facility's proprietary products and formulations. The company also minimizes waste by using water-based chemicals in place of organic-based chemicals wherever possible (SOCMA, 1993).

* Du Pont substituted coal with butadiene in the production of nylon and substituted terephthalic acid for dimethyl terephthalate in the production of polyester. The substitutions eliminated generation of by-products, such as liquid methanol (North Carolina Department of Environment, Health, and Natural Resources, 1995).

* A synthetic fibers and organic chemicals manufacturer eliminated benzene from its manufacturing processes. As a result, the facility simplified its compliance and record keeping procedures since it is no longer subject to the benzene NESHAP (EPA, 1993).

502 IMPROVE CATALYST

Alternative Catalysts

The catalyst plays a critical role in the effectiveness of chemical conversion in the reactor. Alternative catalyst chemical makeups and physical characteristics can lead to substantial improvements in the effectiveness and life of a catalyst. Different catalysts can also eliminate by-product formation. Using a more active catalyst and purchasing catalysts in the active form can reduce catalyst consumption and decrease emissions generated during catalyst activation. Catalyst activity can also be optimized by limiting catalyst residence time in the charge lines (Smith, 1964).

503 OPTIMIZE PROCESSES

Equipment & Process Changes

Process changes that optimize reactions and raw materials use can reduce chemical releases. Developing more reliable reactor operations with fewer upsets can reduce air emissions and pollution from unreacted reactants. Modifications may include improved process control systems, optimized use of chemicals, or equipment modifications. Many larger facilities are using computer controlled systems which analyze the process continuously and respond more quickly and accurately than manual control systems. These systems are often capable of automatic start-ups, shutdowns and product changeover which can bring the process to stable conditions quickly, minimizing the generation of off-spec wastes. Textile fiber manufacturers can optimize use of chemicals and minimize hazardous waste from fiber finishes by improving control of finish add-on and selection of finish components (EPA, 1995).

Processes can also be optimized through equipment retrofits and replacements. For instance, dedicated piping can isolate certain types of solvents from others, avoiding offgrade product and waste production. Equipment and process changes can also minimize by-product waste and improve product yield by lowering polymer conversion rate in the reactors. (Clements and Thompson, 1993).

* BP Chemicals switched from a series of programmable controllers and analog controllers to a distributed control system. The new control system has greater ability to report what is occurring in the reaction tank and provides operators with more opportunity to improve reaction consistency or correct small problems before they become big ones. This results in less reactor downtime and off-spec product (Elley, 1991).

* Du Pont's Wilmington, North Carolina polyester plant reduced its releases and transfers of 33/50 chemicals by 55 percent, or more than 1 million lb/yr between 1988 and 1993. By simplifying manufacturing processes, Du Pont eliminated use of ortho-xylene and generation of methanol and ethylene glycol by-products. This change resulted in savings of over $1 million/yr. The plant also made innovative process modifications which reduced process temperatures and VOC emissions (North Carolina Department of Environment, Health, and Natural Resources, 1995).

Equipment & Process Improvements

* While increasing production in 1990 and 1991, Monsanto's Pensacola, Florida plant implemented process modifications and operational changes in its nylon operations that reduced TRI releases by 74 percent and cyclohexane releases by 96 percent. The plant changed processes and reduced the amount of ammonia required to neutralize nitric acid, a by-product of nylon production. This reduced the amount of ammonium nitrate the company disposed in deep wells by 18 million pounds. The facility also made process modifications and operational changes from 1989 to 1991 which cut cyclohexane releases by 96 percent and installed a new ammonia storage tank which increased safety and reduced air emissions (CMA, 1992).

* Reichhold Chemicals made equipment improvements to reduce waste from product sampling. Special canisters were permanently fixed to production tanks which enabled smaller samples to be taken and later returned to the tanks.

* A synthetic fibers and hydrocarbon resins facility implemented four process modifications to reduce waste. The plant changed to closed purge systems to eliminate emissions in sampling operations, flushed pumps through equipment to process vessels to avoid discharging waste water, optimized the wetting agent amount needed for fibers to reduce oxygen demand in upstream effluent, and modified procedures to require flushing of the system between product grades to minimize off-grade product. These steps reduced waste generated due to off-spec quality by 40 percent (Kikta, 1994).

504 ADOPT GOOD OPERATING PRACTICES

Good Operating Practices

Companies can improve production efficiency and maintain low operating costs by incorporating pollution prevention codes into their management procedures. These codes can include a written commitment by senior management to ongoing waste reduction at each of the company's facilities, inclusion of pollution prevention objectives in research and new facility design, or implementation of employee training and incentive programs. In addition, establishing training programs and improving record keeping are other ways that companies can prevent pollution without changing industrial processes. Employee involvement groups can also be used to identify and implement waste minimization projects within their operational areas, and wastes from lab, maintenance and off-spec materials can be minimized through better housekeeping practices and personnel training (Smith, 1987), (*http://es.inel.gov/techinfo/facts/cma/cma-fs3.html*, 7/96).

Operating Practices

* A specialty batch polymer facility established a facility-wide monetary bonus program aimed at reducing waste on a monthly basis. The company also gave the reactor operator the ability to alter production schedule and recipe parameters to ensure product quality and prevent offgrade production (SOCMA, 1993).

* Du Pont targeted, tracked and reported tabulated wastes. Du Pont defined its "tabulated waste" as RCRA-defined waste, solid waste treated or disposed of on-site or off-site, waste-derived fuels, some recycled materials, deep well injection wastes, and wastewater effluents. The company also chose an environmental coordinator for each waste-generating site, established training programs, and reduced waste through use of belt filters. Du Pont also saved over $12.5 million by implementing a company wide energy efficiency program. Improvements included shutdown of spare or unneeded equipment, tune-up and optimization of systems and processes, renegotiation of fuel, electricity and service contracts, waste heat and condensate return, electrical peak management, fuels inventory reduction, HVAC system management improvements, improved steam trap maintenance program, and system or process improvements (Cleenger and Hassell, 1994).

* At the Du Pont Kinston, North Carolina plant, lube oil waste was significantly reduced through preventative maintenance programs and installation of longer-life oils in certain equipment (North Carolina Department of Environment, Health, and Natural Resources, 1995).

505 MODIFY PRODUCT

Product Modifications

Product modification can eliminate the use of hazardous chemicals, reduce emissions from manufacturing processes, and also decrease emissions from final products. Improvements in product packaging systems and materials can be used to cut back disposal of contaminated product.

* A batch specialty polymer facility has encouraged its customers to eliminate the use of hazardous chemicals wherever possible in their batch specifications (SOCMA, 1993).

* A synthetic fiber and hydrocarbon resin plant reduced product waste from the mechanical failure of its sheet-forming dewatering machine. The company achieved this by rectifying the inadequate design and writing better operating procedures for the machine (Kikta, 1994).

* PPG Industries introduced resins to reformulate industrial paints and thereby lowered VOC emissions and reduced solvent waste by modifying plant equipment and processes. Processes were modified to reformulate resins and eliminate extraneous solvents. These changes made recovery and recycle of solvent easier.

506 PREVENT LEAKS AND SPILLS

Leaks/Spills

Eliminating leaks and spills can be a very cost effective pollution prevention opportunity. Leaks and spills can be prevented by adopting a preventative maintenance program, maintaining a leak detection program, and installing seamless pumps and other "leakless" equipment. Vapor recovery lines can also be used to reduce monomer vapors generated during polymerization and VOCs emitted during unloading of bulk raw materials from tank trucks. Additionally, process water can be used to clean out unloading vehicles and be recycled back into the processes (CMA, 1993).

* Novacor Chemicals replaced three 100,000 gallon monomer storage tanks at its Springfield, MA site and reduced VOC emissions by 8,800 lbs/year. The new tanks are equipped with vapor recovery systems and use a nitrogen gas blanket in the tank head space to prevent volatilization of monomer. Additionally, the tanks are better equipped for fire protection and spill containment (in person interview, M. Garvey, Novacor, 11/96).

* At Texas Eastman's Longview plant, employees monitored thousands of leaking valves and reduced air emissions from those valves by 99 percent, through the development of new valve packing materials (***http://es.inel.gov/studies/eastx-d.html***, 7/96).

* A specialty batch polymer plant initiated an intensive maintenance program to improve wetting agent pump seals and installed curbs around pumps to contain leaks. Refrigerant releases were also lowered by pumping equipment down to very low pressure prior to maintenance (Kikta, 1994).

507 OPTIMIZE CLEANING PRACTICES

Cleaning Practices

Modifying equipment cleaning practices can reduce wastewater discharges and reduce solvent use. Substituting cleaning solvents with less toxic solvents can reduce hazardous waste generation and can simplify treatment of wastewater. Many facilities have switched from using ozone-depleting chemicals to non-ozone-depleting ones. Wastes can also be minimized by either washing out piping and transfer hoses after use or by purchasing dedicated hoses for each product loaded into tankers. Techniques used to minimize fouling on the reactor walls include maintaining a high polish on reactors, using less water-soluble and more active catalysts, and using reflux condensers and water-cooled baffles.

* Monsanto's Pensacola, Florida plant eliminated CFC and methyl chloroform releases by substituting solvents used in its degreasing and cleaning operations (CMA, 1992). In addition, both Du Pont and Monsanto switched from solvents to high-pressure water washing to clean vessels of polymer buildup. This eliminated 180,000 lbs of TRI waste discharged annually to publicly owned treatment works by Monsanto's Indian Orchard plant in Massachusetts.

* Du Pont's Chambers Works plant in New Jersey reduced cleaning waste by 98 percent. The company turned to experts in waterjet engineering, used in the mining industry, to design a special water lance and nozzle. This change cut turnaround time and saved money (***http://es.inel.gov/techinfo/facts/cma/cmafs3.html***, 7/96).

508 IMPROVE INVENTORY MANAGEMENT AND STORAGE

Inventory Storage/ Management

Good inventory management can reduce waste by preventing materials from exceeding their shelf life, preventing materials from being left over or not needed, and reducing the likelihood of accidental releases of stored material. Designating a materials storage area, limiting traffic through the area, and giving one person the responsibility to maintain and distribute materials can reduce materials use and contamination and dispersal of materials.

500 POLLUTION PREVENTION

* At its polyethylene facility in Victoria, Australia, Commercial Polymers adopted a comprehensive water conservation program. Workers read over 20 water meters on a daily basis and adopted water intake minimization strategies based on usage. Water usage has been reduced by 30 percent to about 500 m3 per day (Clements and Thompson, 1993).

509 RECYCLING, RECOVERY AND REUSE

Recycling

Pollution prevention as defined by the Pollution Prevention Act of 1990, recovery, recycling, and reuse can be effective tools for minimizing pollutant releases to the environment. By recovering solvents and raw materials, plastic resin and manmade fiber manufacturers can reduce pollution without modifying existing processes and can reduce raw materials costs. Solvents are widely used in the industries for activities ranging from polymerization and fiber spilling to degreasing and cleaning. Raw materials can also be recycled, such as unreacted monomer, catalyst and additives.

510 RECOVER SOLVENTS

Recovering Solvents

Capturing, purifying and recycling solvents can be an effective method of reducing pollution. Facilities can reduce TRI chemical releases and save money by recycling solvents used in polymerization, fiber manufacture and supporting operations. Common methods used in solvent recovery are evaporation, distillation and carbon adsorption.

* Hoechst installed carbon adsorption solvent recovery units to recover and recycle acetone back to the acetate fiber spinning process. Using carbon adsorption, overall plant acetone recovery efficiency reaches nearly 99 percent. Hoechst plans to achieve additional reductions by revamping air handling and ventilation systems to improve acetone capture.

* A phenol formaldehyde resin manufacturer used distillation and reuse of alcohol wash liquid to reduce waste generation and off-site disposal by 67 percent. The plant had generated 6,000 gal/yr of reactor wash solution containing 50 percent alcohol, phenol formaldehyde resin and water. By recycling the alcohol wash solution, the plant saves $15,000 annually in material and treatment costs (***http://es.inel.gov/studies/cs435.html***, 7/96).

* A specialty batch polymer plant switched to a cryogenic vapor recovery system to minimize the amount of residual solvent trapped by fibers and released with downstream processing (Kikta, 1994).

511 RECOVER RAW MATERIALS

Recycling Raw Materials

By capturing, purifying and recycling raw materials, companies can reduce pollution and raw materials costs. Many companies recycle unreacted monomer back to reactor vessels. This saves money by reducing monomer costs and treatment and disposal costs. Some companies save money by recycling catalyst components.

* Allied Signal's high-density polyethylene plant (Baton Rouge, Louisiana) implemented a chromium recovery process, which uses an ion exchange resin, to reduce the plant's hazardous catalyst waste. The company installed a chromium recovery unit at a cost of $265,000 and saved $500,000 that year in hazardous waste disposal costs.

* Hoechst Celanese recovers Freon, used in the quality control laboratories, for reuse via a glassware batch distillation system. The recovery and reuse of Freon in the laboratory has saved Celanese's Greenville plant over $1,800 a year in disposal and raw material costs. Contaminated heat transfer fluid (Dowtherm) is sent to an off-site distillation facility for recovery and returned for reuse in production. Recycling of heat recovery fluid saves the plant about $164,000 per year in disposal and raw material costs.

* Du Pont recycled pump out solution wastes (polymer and acid) from polyamide fiber production, saving the company disposal, treatment and handling costs.

* Borden Chemical Company recycled phenolic resins and modified its reactor rinse procedures to reduce waste volume and toxicity. Borden switched from a one-rinse system to a two-rinse system. Previously, the plant used 20,000 gallons of water to rinse the reactors. Now, the reactors are first rinsed with 500 - 1000 gallons of water and then rinsed again. The wastewater from the first rinse has a high concentration of resins, which are filtered, rinsed, and recycled back into the process as

raw materials. The filtered wastewater is reused for rinsing (***http://es.inel.gov/studies/cs20.html***, 7/96).

* American Enka used an alternative two-stage precipitation process to recover zinc, which is used in the acid spinning bath process. Zinc is precipitated, treated and returned to the spinning bath. Zinc recycling can be an economical solution that conserves limited resources and reduces waste disposal (***http://es.inel.gov/studies/hmll0053.html***, 7/96).

512 CMA'S RESPONSIBLE CARE® PROGRAM

Responsible Care® Program

The leaders in the plastics and synthetic fibers industries, similar to those in the chemical industry as a whole, have been promoting pollution prevention through various means. The most visible of these efforts is the Responsible Care® initiative of the Chemical Manufacturers Association (CMA). Responsible Care® is mandatory for CMA members who must commit to act as stewards for products through use and ultimate reuse or disposal. One of the guiding principles of this initiative is the inclusion of waste and release prevention objectives in research and in design of new or modified facilities, processes and products.

The following tables, Table 500.1 and Table 500.2, are adapted from the CMA "Designing Pollution Prevention into the Process" manual. These tables cover, in greater detail, those activities which afford the greatest opportunity to utilize source reduction and/or recycle versus treatment as a way to manage waste. The first table covers pollution prevention methods that require process or product modification. The second table describes pollution prevention options that involve changes in equipment design and operation.

Table 500.1: Process/Product Modifications Create Pollution Prevention Opportunities

Process/Product Modifications Create Pollution Prevention Opportunities		
Area	**Potential Problem**	**Possible Approach**
By-products Co-products		
Quantity & Quality	Process inefficiencies result in the generation of undesired by-products & co-products. Inefficiencies will require larger volumes of raw materials & result in additional secondary products. Inefficiencies can also increase fugitive emissions & wastes generated through material handling.	Increase product yield to reduce by-product & co-product generation & raw material requirements.
Uses & Outlets	By-products & co-products are not fully utilized, generating material or waste that must be managed.	Identify uses & develop a sales outlet. Collect information necessary to firm up a purchase commitment such as minimum quality criteria, maximum impurity levels that can be tolerated, & performance criteria.
Catalysts		
Composition	The presence of heavy metals in catalysts can result in contaminated process wastewater from catalyst handling & separation. These wastes may require special treatment and disposal procedures or facilities. Heavy metals can be inhibitory or toxic to biological wastewater treatment units. Sludge from wastewater treatment units may be classified as hazardous due to heavy metals content. Heavy metals generally exhibit low toxicity thresholds in aquatic environmental & may bioaccumulate.	Catalysts comprised of noble metals, because of their cost, are generally recycled by both onsite & offsite reclaimers.
Preparation & Handling	Emissions or effluents are generated with catalyst activation or regeneration. Catalyst attrition & carryover into product requires de-ashing facilities which are a likely source of wastewater & solid waste.	Obtain catalyst in the active form. Provide insitu activation with appropriate processing/activation facilities. Develop a more robust catalyst or support.

500 POLLUTION PREVENTION

Table 500.1: (cont.)

Area	Potential Problem	Possible Approach
Catalysts (cont.)		
Preparation & Handling	Catalyst is spent & needs to be replaced. Pyrophoric catalyst needs to be kept wet, resulting in liquid contaminated w/metals. Short catalyst life.	In situ regeneration eliminates unloading/loading emissions & effluents versus offsite regeneration or disposal. Use a nonpryrophoric catalyst. Minimize amount of water required to handle & store safely.
Effectiveness	Catalyzed reaction has by-product formation, incomplete conversion & less-than-perfect yield. Catalyzed reaction has by-product formation, incomplete conversion & less-than-perfect yield.	Study & identify catalyst deactivation mechanisms. Avoid conditions which promote thermal or chemical deactivation. By extending catalyst life, emissions & effluents associated w/catalyst handling & regeneration can be reduced. Reduce catalyst consumption w/a more active form. A higher concentration of active ingredient or increased surface area can reduce catalyst loadings. Use a more selective catalyst which will reduce the yield of undesired by-products. Improve reactor mixing/contacting to increase catalyst effectiveness. Develop a thorough understanding of reaction to allow optimization of reactor design. Include in the optimization, catalyst consumption and by-product yield.
Intermediate Products		
Quantity & Quality	Intermediate reaction products or chemical species, including trace levels of toxic constituents, may contribute to process waste under both normal & upset conditions. Intermediates may contain toxic constituents or have characteristics that are harmful to the environment.	Modify reaction sequence to reduce amount or change composition of intermediates. Modify reaction sequence to change intermediate properties. Use equipment design & process control to reduce releases.

Table 500.1: (cont.)

Area	Potential Problem	Possible Approach
Process Conditions/Configuration		
Temperature	High heat exchange tube temperatures cause thermal cracking/decomposition of many chemicals. These lower molecular weight by-products are a source of "light ends" & fugitive emissions. High localized temperature gives rise to polymerization of reactive monomers, resulting in "heavies" or "tars." Such materials can foul heat exchange equipment or plug fixed-bed reactors, thereby requiring costly equipment, cleaning & production outage. Higher operating temperatures imply "heat input" usually via combustion which generates emissions. Heat sources such as furnaces & boilers are a source of combustion emissions. Vapor pressure increases w/increasing temperature. Loading/unloading, tankage & fugitive emissions generally increase w/increasing vapor pressure.	Select operating temperatures @ or near ambient temperature whenever possible. Use lower pressure steam to lower temperatures. Use intermediate exchangers to avoid contact w/furnace tubes & walls. Use staged heating to minimize product degradation & unwanted side reactions. Use superheat of high-pressure steam in place of furnace. Monitor exchanger fouling to correlate process conditions which increase fouling, avoid conditions which rapidly foul exchangers. Use online tube cleaning technologies to keep tube surfaces clean to increase heat transfer. Use scraped wall exchangers in viscous service. Use falling film reboiler, pumped recirculation reboiler or high-flux tubes. Explore heat integration opportunities (e.g., use waste heat to preheat materials & reduce the amount of combustion required.) Use thermocompressor to upgrade low-pressure steam to avoid the need for additional boilers & furnaces. If possible, cool materials before sending to storage. Use hot process streams to reheat feeds.

Table 500.1: (cont.)

Area	Potential Problem	Possible Approach
Process Conditions/ Configuration		
Temperature (cont.)		Add vent condensers to recover vapors in storage tanks or process.
		Add closed dome loading w/vapor recovery condensers.
	Water solubility of most chemicals increases w/increasing temperature.	Use lower temperature (vacuum processing.)
Pressure	Fugitive emissions from equipment.	Equipment operating in vacuum service is not a source of fugitives; however, leaks into the process require control when system is degassed.
	Seal leakage potential due to pressure differential.	Minimize operating pressure.
	Gas solubility increases w/higher pressures.	Determine whether gases can be recovered, compressed, & reused or require controls.
Corrosive Environment	Material contamination occurs from corrosion products. Equipment failures result in spills, leaks & increased maintenance costs.	Improve metallurgy or provide coating or lining.
		Neutralize corrosivity of materials contacting equipment.
	Increased waste generation due to addition of corrosion inhibitors or neutralization.	Use corrosion inhibitors.
		Improve metallurgy or provide coating or lining or operate in a less corrosive environment.
Batch vs. Continuous Operations	Vent gas lost during batch fill.	Equalize reactor & storage tank vent lines.
		Recover vapors through condenser, adsorber, etc.
	Waste generated by cleaning/purging of process equipment between production batches.	Use materials with low viscosity. Minimize equipment roughness.

Table 500.1: (cont.)

Area	Potential Problem	Possible Approach
Process Conditions/Configuration		
Batch vs. Continuous Operations (cont.)	Process inefficiencies lower yield & increase emissions. Continuous process fugitive emissions & waste increase over time due to equipment failure through a lack of maintenance between turnarounds.	Optimize product manufacturing sequence to minimize washing operations & cross-contamination of subsequent batches. Sequence addition of reactants & reagents to optimize yields & lower emissions. Design facility to readily allow maintenance so as to avoid unexpected equipment failure & resultant release.
Process Operation/Design	Numerous processing steps create wastes & opportunities for errors.	Keep it simple. Make sure all operations are necessary. More operations & complexity only tend to increase potential emission & waste sources.
	Nonreactant materials (solvents, absorbants, etc.) create wastes. Each chemical (including water) employed within the process introduces additional potential waste sources; the composition of generated wastes also tends to become more complex. High conversion w/low yield results in wastes.	Evaluate unit operation or technologies (e.g., separation) that do not require the addition of solvents or other nonreactant chemicals. Recycle operations generally improve overall use of raw materials & chemicals, thereby both increasing the yield of desired products while @ the same time reducing the generation of wastes. A case-in-point is to operate @ a lower conversion per reaction cycle by reducing catalyst consumption, temperature, or residence time. Many times, this can result in a higher selectivity to desired products. The net effect upon recycle of unreacted reagents is an increase in product yield, while @ the same time reducing the quantities of spent catalyst & less desirable by-products.

Table 500.1: (cont.)

Area	Potential Problem	Possible Approach
Process Conditions/Configuration		
Process Operation/Design	Non-regenerative treatment systems result in increased waste vs. regenerative systems.	Regenerative fixed bed treating or desiccant operation (e.g., aluminum oxide silica, activated carbon, molecular sieves, etc.) will generate less quantities of solid or liquid waste than nonregenerative units (e.g., calcium chloride or activated clay.) With regenerative units though, emissions during bed activation & regeneration can be significant. Further, side reactions during activation/regeneration can give rise to problematic pollutants.
Product		
Process Chemistry	Insufficient R&D into alternative reaction pathways may miss pollution opportunities such as waste reduction or eliminating a hazardous constituent.	R&D during process conception & laboratory studies should thoroughly investigate alternatives in process chemistry that affect pollution prevention.
Product Formulation	Product based on end-use performance may have undesirable environmental impacts or use raw materials or components that generate excessive or hazardous wastes.	Reformulate products by substituting different material or using a mixture of individual chemicals that meet end-use performance specifications.
Raw Materials		
Purity	Impuritites may produce unwanted by-products & waste. Toxic impurities, even in trace amounts, can make a waste hazardous & therefore subject to strict & costly regulation. Excessive impurities may require more processing & equipment to meet product specifications, increasing costs & potential for fugitive emissions, leaks, & spills. Specifying a purity greater than needed by the process increases costs & can result in more waste generation by the supplier.	Use higher purity materials. Purify materials before use & reuse if practical. Use inhibitors to prevent side reactions. Achieve balance between feed purity, processing steps, product quality & waste generation. Specify a purity no greater than what the process needs.

Table 500.1: (cont.)

Area	Potential Problem	Possible Approach
Raw Materials (cont.)		
Purity (cont.)	Impurities in clean air can increase inert purges.	Use pure oxygen.
	Impurities may poison catalyst prematurely resulting in increased wastes due to yield loss & more frequent catalyst replacement.	Install guard beds to protect catalysts.
Vapor Pressure	Higher vapor pressures increase fugitive emissions in material handling & storage.	Use material w/lower vapor pressure.
	High vapor pressure w/low odor threshold materials can cause nuisance odors.	Use materials w/lower vapor pressure & higher odor threshold.
Water Solubility	Toxic or nonbiodegradable materials that are water soluble may affect wastewater treatment operation, efficiency, & cost.	Use less toxic or more biodegradable materials.
	Higher solubility may increase potential f/surface & groundwater contamination & may require more careful spill prevention, containment, & cleanup (SPCC) plans.	Use less soluble materials.
	Higher solubility may increase potential f/storm water contamination in open areas.	Use less soluble materials. Prevent direct contact w/storm water by diking or covering areas.
	Process wastewater associated w/water washing or hydrocarbon/water phase separation will be impacted by containment solubility in water. Appropriate wastewater treatment will be impacted.	Minimize water usage. Reuse wash water. Determine optimum process conditions f/phase separation. Evaluate alternative separation technologies (coalescers, membranes, distillation, etc.)

Table 500.1: (cont.)

Area	Potential Problem	Possible Approach
Raw Materials (cont.)		
Toxicity	Community & worker safety & health concerns result from routine & nonroutine emissions. Emissions sources include vents, equipment leaks, wastewater emissions, emergency pressure relief, etc. Surges or higher than normal continuous levels of toxic materials can shock or miss wastewater biological treatment systems resulting in possible fines & possible toxicity in the receiving water.	Use less toxic materials. Reduce exposure through equipment design & process control. Use systems which are passive for emergency containment of toxic releases. Use less toxic material. Reduce spills, leaks, & upset conditions through equipment & process control. Consider effect of chemicals on biological treatment; provide unit pretreatment or diversion capacity to remove toxicity. Install surge capacity for flow & concentration equalization.
Regulatory	Hazardous or toxic materials are stringently regulated. They may require enhanced control & monitoring; increased compliance issues & paperwork for permits & record keeping; stricter control for handling, shipping, & disposal; higher sampling & analytical costs; & increased health & safety costs.	Use materials which are less toxic or hazardous. Use better equipment & process design to minimize or control releases; in some cases, meeting certain regulatory criteria will exempt a system from permitting or other regulatory requirements.
Form of Supply	Small containers increase shipping frequency which increases chances of material releases & waste residues from shipping containers (including wash waters.) Nonreturnable containers may increase waste.	Use bulk supply, ship by pipeline, or use "jumbo" drums or sacks. In some cases, product may be shipped out in the same containers the material supply was shipped in without washing. Use returnable shipping containers or drums.
Handling & Storage	Physical state (solid, liquid, gaseous) may raise unique environmental, safety, & health issues with unloading operations & transfer to process equipment.	Use equipment & controls appropriate to the type of materials to control releases.

Table 500.1: (cont.)

Area	Potential Problem	Possible Approach
Raw Materials (cont.)		
Handling & Storage (cont.)	Large inventories can lead to spills, inherent safety issues & material expiration.	Minimize inventory by utilizing just-in-time delivery.
Waste Streams		
Quantity & Quality	Characteristics & sources of waste streams are unknown.	Document sources & quantities of waste streams prior to pollution prevention assessment.
	Wastes are generated as part of the process.	Determine what changes in process conditions would lower waste generation of toxicity.
		Determine if wastes can be recycled back into the process.
Composition	Hazardous or toxic constituents are found in waste streams. Examples are: sulfides, heavy metals, halogenated hydrocarbons, & polynuclear aromatics.	Evaluate whether different process conditions, routes, or reagent chemicals (e.g., solvent catalysts) can be substituted or changed to reduce or eliminate hazardous or toxic compounds.
Properties	Environmental fate & waste properties are not known or understood.	Evaluate waste characteristics using the following type properties: corrosivity, ignitability, reactivity, BTU content (energy recovery), biodegradability, aquatic toxicity, & bioaccumulation potential of the waste & of its degradable products, & whether it is a solid, liquid, or gas.
Disposal	Ability to treat & manage hazardous & toxic waste unknown or limited.	Consider & evaluate all onsite & offsite recycle, reuse, treatment & disposal options available. Determine availability of facilities to treat or manage wastes generated.

Source: Chemical Manufacturers Association, *Designing Pollution Prevention into the Process, Research, Development and Engineering,* Washington, D.C., 1993.

Table 500.2: Modifications to Equipment for Pollution Prevention

		Possible Approach	
Equipment	**Potential Environmental Problem**	**Design Related**	**Operational Related**
Compressors, blowers, fans	Shaft seal leaks, piston rod seal leaks, & vent streams	Seal-less designs (diaphragmatic, hermetic or magnetic) Design for low emissions (internal balancing, double inlet, gland eductors) Shaft seal designs (carbon rings, double mechanical seals, buffered seals) Double seal w/barrier fluid vented to control device	Preventive maintenance program
Concrete pads, floors, sumps	Leaks to groundwater	Water stops Embedded metal plates Epoxy sealing Other impervious sealing	Reduce unnecessary purges, transfers, & sampling Use drip pans where necessary
Controls	Shutdowns & start-ups generate waste & releases	Improve on-line controls On-line instrumentation Automatic start-up & shutdown On-line vibration analysis Use "consensus" systems (e.g., shutdown trip requires 2 out of 3 affirmative responses)	Continuous versus batch Optimize on-line run time Optimize shutdown interlock inspection frequency Identify safety & environment critical instruments & equipment
Distillation	Impurities remain in process streams	Increase reflux ratio Add section to column Column intervals Change feed tray	Change column operating conditions - reflux ratio - feed tray - temperature - pressure - etc.

Table 500.2: (cont.)

		Possible Approach	
Equipment	**Potential Environmental Problem**	**Design Related**	**Operational Related**
Distillation (cont.)	Impurities remain in process streams (cont.) Large amounts of contaminated water condensate from stream stripping	Insulate to prevent heat loss. Preheat column feed. Increase vapor line size to lower pressure drop. Use reboilers or inert gas stripping agents.	Clean column to reduce fouling. Use higher temperature steam.
General manufacturing equipment areas	Contaminated rainwater Contaminated sprinkler & fire water Leaks & emissions during cleaning	Provide roof over process facilities. Segregate process sewer from storm sewer (diking). Hard-pipe process streams to process sewer. Seal floors Drain to sump Route to waste treatment Design for cleaning Design for minimum rinsing Design for minimum sludge Provide vapor enclosure Drain to process	Return samples to process Monitor stormwater discharge Use drip pans for maintenance activities. Rinse to sump Reuse cleaning solutions
Heat exchangers	Increased waste due to high localized temperatures	Use intermediate exchangers to avoid contact with furnace tubes & walls. Use staged heating to minimize product degradation & unwanted side reactions (waste heat>>low pressure steam>>high pressure steam).	Select operating temperatures @ or near ambient temperature whenever possible. These are generally most desirable from a pollution prevention standpoint. Use lower pressure steam to lower temperatures.

Table 500.2: (cont.)

		Possible Approach	
Equipment	Potential Environmental Problem	Design Related	Operational Related
Heat exchangers (cont.)	Increased waste due to high localized temperatures (cont.) Contaminated materials due to tubes leaking @ tube sheets Furnace emissions	Use scraped wall exchangers in viscous service. Using falling film reboiler, piped recirculation reboiler or high-flux tubes. Use lowest pressure steam possible. Use welded tubes or double tube sheets with inert purge. Mount vertically. Use superheat of high-pressure steam in place of a furnace.	Monitor exchanger fouling to correlate process conditions which increase fouling, avoid conditions which rapidly foul exchangers. Use on-line tube cleaning techniques to keep tube surfaces clean. Monitor for leaks.
Piping	Leaks to groundwater; fugitive emissions	Design equipment layout so as to minimize pipe run length. Eliminate underground piping or design for cathodic protection if necessary to install piping underground. Welded fittings Reduce number of flanges & valves. All welded pipe Secondary containment Spiral-would gaskets Use plugs & double valves for open end lines. Change metallurgy Use lined pipe.	Monitor for corrosion & erosion. Paint to prevent external corrosion.

Table 500.2: (cont.)

		Possible Approach	
Equipment	**Potential Environmental Problem**	**Design Related**	**Operational Related**
Piping (cont.)	Releases when cleaning or purging lines	Use "pigs" for cleaning. Slope to low point drain. Use heat tracing & insulation to prevent freezing. Install equalizer lines.	Flush to product storage tank
Pumps	Fugitive emissions from shaft seal leaks	Mechanical seal in lieu of packing. Double mechanical seal with inert barrier fluid Double machined seal with barrier fluid vented to control device Seal-less pump (canned motor magnetic drive) Vertical pump	Seal installation practices. Monitor for leaks.
	Fugitive emissions from shaft seal leaks	Use pressure transfer to eliminate pump.	
	Residual "heel" of liquid during pump maintenance	Low point drain on pump casing	Flush casing to process sewer for treatment.
	Injection of seal flush fluid into process stream	Use double mechanical seal with inert barrier fluid where practical.	Increase the mean time between pump failures by: - selecting proper seal material; - good alignment; - reduce pipe-induced stress; - maintaining seal lubrication
Reactors	Poor conversion or performance due to inadequate mixing	Static mixing Add baffles Change impellers	Add ingredients with optimum sequence.

Table 500.2: (cont.)

		Possible Approach	
Equipment	**Potential Environmental Problem**	**Design Related**	**Operational Related**
Reactors (cont.)	Poor conversion (cont.)	Add horsepower. Add distributor.	Allow proper head space in reactor to enhance vortex effect.
	Waste by-product formation	Provide separate reactor for converting recycle streams to usable products.	Optimize reaction conditions (temperature, pressure, etc.).
Relief Valve	Leaks	Provide upstream rupture disc.	Monitor for leaks & for control efficiency.
	Fugitive emissions	Vent to control or recovery device.	Monitor for leaks.
	Discharge to environment from over pressure	Pump discharges to suction of pump. Thermal relief to tanks. Avoid discharge to roof areas to prevent contamination of rainwater.	
	Frequent relief	Use pilot operated relief valve. Increase margin between design & operating pressure.	Reduce operating pressure. Review system performance.
Sampling	Waste generation due to sampling (disposal, containers, leaks, fugitives, etc.)	In-line insitu analyzers System for return to process Closed loop Drain to sump	Reduce number & size of samples required. Sample @ the lowest possible temperature. Cool before sampling.
Tanks	Tank breathing & working losses	Cool materials before storage. Insulate tanks. Vent to control device (flare, condenser, etc.). Vapor balancing Floating roof	Optimize storage conditions to reduce losses.

Table 500.2: (cont.)

		Possible Approach	
Equipment	Potential Environmental Problem	Design Related	Operational Related
Tanks (cont.)	Tank breathing & working losses (cont.)	Higher design pressure	
	Leak to groundwater	All aboveground (situated so bottom can routinely be checked for leaks)	Monitor for leaks & corrosion.
		Secondary containment	
		Improve corrosion resistance	
	Large waste heel	Design for 100% de-inventory	Recycle to process if practical.
Vacuum Systems	Waste discharge from jets	Substitute mechanical vacuum pump. Evaluate using process fluid for powering jet.	Monitor for air leaks. Recycle condensate to process.
Valves	Fugitive emissions from leaks	Bellow seals. Reduce number where practical. Special packing sets	Stringent adherence to packing procedures
Vents	Release to environment.	Route to control or recovery device.	Monitor performance.

Source: Chemical Manufacturers Association, *Designing Pollution Prevention into the Process, Research, Development and Engineering*, Washington, D.C., 1993.

*The **California Air Resources Board's (ARB) Training Section**, located in the Compliance Division, has published **Pollution Prevention Primer.** A copy may be downloaded at **www.arb.ca.gov/pp/primer/primer.htm.** For more information call (916) 322-3976.*

600 LEGAL REQUIREMENTS

601 VISIBLE EMISSIONS

Visible Emissions

U.S. EPA Method 9 (Visual Determination of the Opacity of Emissions from Stationary Sources) is found in the Appendices. The method requires the recording of certain specific information in the field documentation of a visible emission observation. The required information includes the name of the facility, the emission location, the type of facility, the observer's name and affiliation, the date, the time, the estimated distance to the emission location, the approximate wind speed and direction, a description of the sky, and the plume background, in addition to a minimum of 24 consecutive opacity observations taken once every 15 seconds.

In California, the visible emission regulation is in Section 41701 of the California Health and Safety Code. The limit in the Health and Safety Code is a Ringelmann No. 2 for dark colored emissions and is 40 percent opacity for light colored emissions. The Ringelmann chart is a gray to black smoke scale published by the United States Bureau of Mines with a range from 0 to 5. "0" represents no visible smoke and "5" is 100 percent opaque or totally black smoke. In most local air quality districts, the acceptable limit is Ringelmann No. 1 or 20 percent opacity. California provides that an aggregate of any 13 or more readings above the limit (totaling more than 3 minutes) taken in a 1-hour period is a violation.

The Compliance Division of the ARB conducts a "Fundamentals of Enforcement" class four times a year to train and certify government and industry personnel to perform these evaluations. The certification is valid for a period of six months, after which recertification is required.

Observe all stacks for emissions which would violate the opacity or Ringelmann limitations in your district regulations. Remember, you must be certified to do a visible emissions evaluation. A visible emissions evaluation (VEE) kit should be available to the inspector. The kit should include:

VEE Forms	Range finder - to measure distance to the stack
Binoculars	Psychrometer - to calculate relative humidity
Wind gauge	Inclinometer - to measure angle of view to stack
Stop Watch	Compass
Camera and film	Water bottle
Pens/Flashlight	Ringelmann chart

600 LEGAL REQUIREMENTS

601.1 PARTICULATE MATTER EMISSION LIMITS

Particulate Matter

Air pollution control districts have general rules which apply to any source operation which emits or may emit dust, fumes, or suspended particulate matter. Some rules specify limits by concentration, in grains per cubic foot, for example; other rules specify weight of emissions per unit of production. Most districts have both limits. To determine the concentrations of particulate emissions at facilities, most districts use ARB Method 5. EPA Method 5 is very similar and can also be used.

601.2 NUISANCE

Nuisance

District rules based on Section 41700, HSC, protect the public's health and welfare from the discharge of air contaminants which constitute a public nuisance. This concept includes protection from injury, detriment, and annoyances such as odors from emissions.

602 EQUIPMENT BREAKDOWN PROVISIONS

Equipment Malfunction Rules

Each district has an equipment breakdown (or excusable equipment malfunction) rule. The rule enables a source qualifying under stated conditions to avoid enforcement action otherwise precipitated by failure of that source to comply with air pollution regulations as a result of a malfunction of any air pollution control equipment or related operating equipment. Malfunctions of in-stack monitoring equipment are also addressed in this rule.

Sources should keep a copy of the breakdown rule on location. They should also be familiar with their responsibilities in the event of an equipment malfunction.

The conditions that a malfunction must meet in order to qualify for district breakdown provisions vary from district to district. Typically, the following are conditions for an acceptable breakdown:

1. The breakdown must result from a failure that was unforeseeable;
2. It must not be the result of neglect or disregard of any air pollution control law or rule or regulation;
3. It must not be intentional, or the result of negligence;
4. It must not be the result of improper maintenance;
5. It must not constitute a nuisance; and,

6. It must not be an abnormally recurrent breakdown of the same equipment.

Equipment Breakdown Reporting

District rules also list a number of procedures which must be followed in reporting the breakdown in a timely manner to the district. If the breakdown is not reported to the district within the allowed time period, as stated in the rule, a separate violation occurs, for which enforcement action is appropriate.

When a breakdown is reported to the district it is recorded in the district's breakdown log. Sources must provide the district with the following information:

1. The source's name and location, and the source's contact name and telephone number;
2. The specific equipment affected by the breakdown;
3. The specific equipment that failed;
4. The date and time that the breakdown occurred;
5. The date and time that the breakdown is being reported to the district;
6. The source's proposed action; and,
7. The estimated emissions resulting from the breakdown.

Upon receipt of a breakdown report, the district performs an investigation to determine whether the malfunction meets the prescribed breakdown conditions. This investigation includes an onsite inspection of the malfunctioning equipment. If the inspector does not find a breakdown condition at the source, he/she may take appropriate enforcement action including, but not limited to, seeking fines, an abatement order, or an injunction against further operation.

If a source files a breakdown report which falsely, or without probable cause, claims a malfunction to be a breakdown occurrence, this shall constitute a separate violation. The burden of proof shall be on the source to provide sufficient information that a breakdown did occur. If the source fails to do this, the district will undertake appropriate enforcement action.

A source with a breakdown must take immediate steps to correct the equipment malfunction as quickly as possible. If a source finds that a malfunction cannot be repaired within the district's allowable duration of a breakdown, the source may file for an emergency variance in order to avoid enforcement action.

District rules require sources to submit in writing the following details to the district air pollution control officer within a stated time period of the correction of the breakdown occurrence:

Equipment Breakdowns

1. The duration of excessive emissions;
2. An estimate of the quantity of excess emissions;
3. A statement of the cause of the occurrence;
4. Corrective measures to be taken to prevent recurrences; and,
5. Proof of the source's return to compliance, including the date and time that the breakdown was corrected.

Besides the information mentioned above, the district log will also include the following items, some of which will be filled in as the case continues:

1. A confirmation that the breakdown is allowable under district rules;
2. The name of the district investigator;
3. The initial inspection file number;
4. The compliance confirmation inspection file number;
5. The date that the breakdown correction report was filed by the source; and,
6. An indication if a variance was requested.

603 VARIANCES

A source may petition for a variance if either of the following is true:

Variance Petition

1. Pollution control equipment has broken down and meets the criteria for breakdown condition under district rules; however, the source operator finds that it will take longer to repair the breakdown than provided for under the district breakdown rule. In such a case, a source operator may wish to apply for an emergency variance.

2. A source finds itself to be out of compliance, is found to be out of compliance, or expects to soon be out of compliance, with any air pollution control district rule or regulation, or with Section 41701 of the California Health and Safety Code (H&SC).

If a source falls into either of the above categories at any time, it should consider applying for a variance. A source's purpose in applying for a variance is to attempt to shield itself from state and local enforcement action while it is out of compliance. Federal regulations do not have a variance provision and a variance cannot protect against federal enforcement actions. Sources should be advised that the initiative to file for a variance and to prove that they need a variance rests on them.

Variances

A source can apply for a short variance (90 day maximum) or a regular variance (over 90 days and one year maximum unless a schedule of increments of progress is included). Interim variances are also available which gives the source protection from enforcement action until their original application for variance can be noticed and heard by the hearing board, or up to 90 days, whichever is shorter. Interim and emergency variance orders, if issued, are typically granted the same day they are requested. A written petition must be submitted before these (and all other) variances are granted.

It is the source's responsibility to estimate the amount of time it will need to be under variance, and to then apply for the appropriate type of variance.

A source should be aware that the decision on whether to grant any variance rests with the district variance hearing board and not with the air pollution control officer or that person's staff.

Rules for variance procedures vary from district to district. The district rules are based on H&SC statutes, however, in some districts the rules are stricter than H&SC requirements. Some of the applicable statutes are listed in this section of the manual. District personnel as well as source operators should be familiar with these statutes and with the local district variance rules.

With regard to variances, State law (H&SC) requires that:

1. The district should not allow sources to operate in violation of district rules without a variance, even if the source is working towards finding a solution to the problem. Source operators should be aware that under H&SC Section 42400.2, if they continue to operate in violation of district rules, they are subject to a $25,000 per day fine and up to 12 months in jail.

2. All variance hearings should be noticed properly in accordance with H&SC Sections 40820 through 40830. Section 40826 requires a 30-day notice period for hearings for variances over a 90-day duration. For districts with a population of 750,000 or less, the notice is 15 days.

3. No variance shall be granted unless the hearing board makes all of the findings listed in H&SC, Section 42352.

600 LEGAL REQUIREMENTS

Variances

The Air Resources Board recommends that the following procedures be observed in the various stages involved from the time a source petitions for a variance through the end of the variance period. Some of these recommendations may not be a part of all districts' variance programs at this time; or, they may be written but not implemented procedures.

1. Parties petitioning for variances should be required to fill out a petition form in writing.

2. The district will require sources to provide excess emissions figures on the petitions they submit. This information will be evaluated by the district staff. The emission figures are presented to the hearing board, so that the board formally recognizes, and the public may be aware of, the emissions impact of the variance. If the variance is granted, these limits must be included in the final variance order.

3. An interim variance can be granted to cover the time period from filing the petition for a regular or short variance until a decision is rendered on whether the variance is granted. This interim variance can subject the source to operating conditions during that interim period.

4. Variances should not be granted retroactively. The date that variance coverage begins cannot predate the date on which the petition was filed.

5. Each variance order will specify the equipment under variance and the district rule or regulation violated.

6. The district should schedule increments of progress for sources under variance. Increments of progress are required for variances over one year. District staff should verify that the source is meeting these increments of progress.

7. The district should require the source to quantify excess emissions that will occur during the period of variance.

8. At the end of the variance period, the district shall inspect the source to ensure that it is in compliance with all district air pollution regulations.

604 HEALTH AND SAFETY CODE

Health & Safety Code Regulations for California

The following California Health and Safety Code (H&SC) references are included to demonstrate the authority of district air pollution control districts to adopt regulations, issue permit conditions, perform inspections and pursue enforcement action. Please note that these regulations are subject to change and the reader is cautioned to refer to the current version of the H&SC when necessary. The relevant Health and Safety Code Sections are presented in numerical order:

39000	Legislative Findings - Environment
39001	Legislative Findings - Agency Coordination
39002	Local and State Agency Responsibilities
39003	ARB Responsibilities
40000	Local/State Responsibilities
40001	Adoption and Enforcement of Rules and Regulations
40702	Adoption of Rules and Regulations
40823	Hearing Board Shall Serve 10 Days Notice
40824	Reasonable Notice for Interim Variance
40825	10 Day Notice for Variances up to 90 Days
40826	30 Day Notice for Regular Variances
41509	No Limitation on Power to Abate Nuisance
41510	Right of Entry With Inspection Warrant
41700	No Person Shall Discharge Pollutants (Public Nuisance)
41701	No Emissions Shall Exceed Ringelmann 2 (Ringelmann/Opacity Standards)
42300	District Permit System
42301	Requirements For Permit Issuance
42303	Air Contaminant Discharge: Information Disclosure
42303.5	False Statements in Permit Applications
42304	False Suspension (Failure to Supply Information)
42350	Applications for Variance
42351	Interim Variance Applications
42351.5	Interim Authorization of Schedule Modification
42352	Findings Required for Issuance of Variance
42353	Other Requirements for Specified Industry, Business, Activity or Individuals
42354	Wide Discretion in Prescribing Requirements
42355	Hearing Board Bond Requirements

600 LEGAL REQUIREMENTS

Health & Safety Code Regulations for California

42356	Hearing Board Variance Modification or Revocation
42357	Hearing Board Review of Schedule of Increments of Progress or Final Compliance Date
42358	Effective Period of Order, Final Compliance Date
42359	Public Hearing Requirements; Emergency Exceptions
42359.5	Emergency Variances
42360	Copy of Variance Orders to ARB
42361	Validity of Variance Time
42362	Variance Revocation or Modification
42363	ARB Hearing Prior to Action
42364	Schedule of Fees
42400	General Violations, Criminal
42400.1	Negligence, Criminal
42400.2	Document Falsification or Failure to Take Corrective Action, Criminal
42400.3	Willfully and Intentionally Emitting an Air Contaminant
42401	Violating Order of Abatement, Civil
42402	General Violations, Civil
42402.1	Negligence or Actual Injury, Civil
42402.2	Document Falsification or Failure to Take Corrective Action, Civil
42402.3	Civil Penalties
42402.5	Administrative Penalties
42403	Recovery of Civil Penalties
42404.5	Statute of Limitations for Civil Actions
42450	Orders of Abatement: District Board; Authority; Notice of Hearing
42700	Monitoring Devices: Legislative Findings & Declarations
42701	Determination of Availability, Technological Feasibility, and Economic Reasonableness
42702	Specification of Types of Stationary Sources, Processes and Contaminants
42703	Reimbursement for Actual Testing Expenses
42704	Determination of Availability; Revocation or Suspension
42705	Records
42706	Report of Violation of Emission Standard
42707	Inspection; Fees
42708	Powers of Local or Regional Authority

39000 LEGISLATIVE FINDINGS - ENVIRONMENT

Legislative Findings

The Legislature finds and declares that the people of the State of California have a primary interest in the quality of the physical environment in which they live, and that this physical environment is being degraded by the waste and refuse of civilization polluting the atmosphere, thereby creating a situation which is detrimental to the health, safety, welfare, and sense of well-being of the people of California.

39001 AGENCY COORDINATION

Agency Coordination

The Legislature, therefore, declares that this public interest shall be safeguarded by an intensive, coordinated state, regional, and local effort to protect and enhance the ambient air quality of the state. Since air pollution knows no political boundaries, the Legislature declares that a regional approach to the problem should be encouraged whenever possible and, to this end, the state is divided into air basins. The state should provide incentives for such regional strategies, respecting, when necessary, existing political boundaries.

39002 LOCAL AND STATE RESPONSIBILITIES

Local & Regional Authorities

Local and regional authorities have the primary responsibility for control of air pollution from all sources other than vehicular sources. The control of vehicular sources, except as otherwise provided in this division, shall be the responsibility of the State Air Resources Board. Except as otherwise provided in this division, including, but not limited to, Sections 41809, 41810, and 41904, local and regional authorities may establish stricter standards than those set by law or by the state board for nonvehicular sources. However, the state board shall, after holding public hearings as required in this division, undertake control activities in any area wherein it determines that the local or regional authority has failed to meet the responsibilities given to it by this division or by any other provision of law.

39003 ARB RESPONSIBILITIES

State Air Resources Board

The State Air Resources Board is the state agency charged with coordinating efforts to attain and maintain ambient air quality standards, to conduct research into the causes of and solution to air pollution, and to systematically attack the serious problem caused by motor vehicles, which is the major source of air pollution in many areas of the state.

600 LEGAL REQUIREMENTS

40000 LOCAL/STATE RESPONSIBILITIES

California's Responsibilities

The Legislature finds and declares that local and regional authorities have the primary responsibility for control of air pollution from all sources, other than emissions from motor vehicles. The control of emissions from motor vehicles, except as otherwise provided in this division, shall be the responsibility of the state board.

40001 ADOPTION OF REGULATIONS

Local District Rules & Regulations

(a) Subject to the powers and duties of the state board, the districts shall adopt and enforce rules and regulations to achieve and maintain the state and federal ambient air quality standards in all areas affected by emission sources under their jurisdiction, and shall enforce all applicable provisions of state and federal law.

(b) The district rules and regulations may, and at the request of the state board shall, provide for the prevention and abatement of air pollution episodes which, at intervals, cause discomfort or health risks to, or damage to the property of, a significant number of persons or class of persons.

(c) Prior to adopting any rule or regulation to reduce criteria pollutants, a district shall determine that there is a problem that the proposed rule or regulation will alleviate and that the rule or regulation will promote the attainment or maintenance of state or federal ambient air quality standards.

(d) (1) The district rules and regulations shall include a process to approve alternative methods of complying with emission control requirements that provide equivalent emission reductions, emissions monitoring, or record keeping.

(2) A district shall allow the implementation of alternative methods of emission reduction, emissions monitoring, or record keeping if a facility demonstrates to the satisfaction of the district that those alternative methods will provide equivalent performance. Any alternative method of emission reduction, emissions monitoring, or record keeping proposed by the facility shall not violate other provisions of law.

(3) If a district rule specifies an emission limit for a facility or system, the district shall not set operational or effectiveness requirements for any specific emission control equipment operating on a facility or system under that limit.

Any alternative method of emission reduction, emissions monitoring, or record keeping proposed by the facility shall include the necessary operational and effectiveness measurement elements that can be included as permit conditions by the district to ensure compliance with, and enforcement of, the equivalent performance requirements of paragraphs (1) and (2). Nothing in this subdivision limits the district's authority to inspect a facility's equipment or records to ensure operational compliance. This paragraph shall apply to existing rules and facilities operating under those rules.

40702 ADOPTION OF RULES AND REGULATIONS

Adoption of Rules/Regulations

A district shall adopt rules and regulations and do such acts as may be necessary or proper to execute the powers and duties granted to, and imposed upon, the district by this division and other statutory provisions. No order, rule, or regulation of any district shall, however, specify the design of equipment, type of construction, or particular method to be used in reducing the release of air contaminants from railroad locomotives.

40823 HEARINGS - 10 DAYS NOTICE

Hearings

(a) Except as otherwise provided in Sections 40824, 40825, and 40826, a hearing board shall serve a notice of the time and place of a hearing upon the district air pollution control officer, and upon the applicant or permittee affected, not less than 10 days prior to such hearing.

(b) Except as otherwise provided in Sections 40824, 40825, and 40826, the hearing board shall also send notice of the hearing to every person who requests such notice and obtain publication of such notice in at least one daily newspaper of general circulation within the district. The notice shall state the time and place of the hearing and such other information as may be necessary to reasonably apprise the people within the district of the nature and purpose of the meeting.

40824 REASONABLE NOTICE - INTERIM VARIANCE

Interim Variances

In case of a hearing to consider an application for an interim variance, as authorized under Section 42351:

(a) The hearing board shall serve reasonable notice of the time and place of the hearing upon the district air pollution control officer and upon the applicant.

600 LEGAL REQUIREMENTS

(b) Subdivision (b) of Section 40823 shall not apply.

(c) In districts with a population of less than 750,000, the chairperson of the hearing board designated by the board, may hear an application for an interim variance. If any member of the public contests a decision made by a single member of the hearing board, the application shall be reheard by the full hearing board within 10 days of the decision.

90 Day Variances

40825 10 DAY NOTICE - 90 DAY VARIANCES

In case of a hearing to consider an application for a variance, or a series of variances, to be in effect for a period of not more than 90 days, or an application for modification of a schedule of increments or progress:

(a) The hearing board shall serve a notice of the time and place of a hearing to grant such a variance or modification upon the air pollution control officer, all other districts within the air basin, the state board, the Environmental Protection Agency, and upon the applicant or permittee, not less than 10 days prior to such hearing.

(b) Subdivision (b) of Section 40823 shall not apply.

(c) In districts with a population of less than 750,000, the chairman of the hearing board, or any other member of the hearing board designated by the board, may hear such an application. If any member of the public contests a decision made by a single member of the hearing board, the application shall be reheard by the full hearing board within 10 days of the decision.

Regular Variances

40826 30 DAY NOTICE - REGULAR VARIANCES

In case of a hearing to consider an application for a variance, other than an interim variance or a 90-day variance, or an application for a modification of a final compliance date in a variance previously granted, the notice requirements for the hearing shall be as follows:

(a) The hearing board shall serve a notice of the time and place of a hearing to grant a variance upon the air pollution control officer, all other districts within the air basin, the state board, the Environmental Protection Agency, and upon the applicant or permittee, not less than 30 days prior to the hearing, except as provided in subdivision (d).

Regular Variances

(b) The hearing board shall also publish a notice of the hearing in at least one daily newspaper of general circulation in the district, and shall send the notice to every person who requests the notice, not less than 30 days prior to the hearing, except as provided in subdivision (d).

(c) The notice shall state the time and place of the hearing; the time when, commencing not less than 30 days, or, under subdivision (d), not less than 15 days, prior to the hearing, and place where the application, including any proposed conditions or schedule of increments of progress, is available for public inspection; and any other information that may be necessary to reasonably apprise the people within the district of the nature and purpose of the meeting.

(d) In districts with a population of 750,000 or less, the hearing board shall serve, publish, and send the notice pursuant to subdivisions (a) and (b) not less than 15 days prior to the hearing.

41509 POWER TO ABATE NUISANCE

Abate Nuisances

No provision of this division, or of any order, rule, or regulation of the state board or of any district, is a limitation on:

(a) The power of any local or regional authority to declare, prohibit, or abate nuisances.

(b) The power of the Attorney General, at the request of a local or regional authority, the state board, or upon his own motion, to bring an action in the name of the people of the State of California to enjoin any pollution or nuisance.

(c) The power of a state agency in the enforcement or administration of any provision of law which it is specifically permitted or required to enforce or administer.

(d) The right of any person to maintain at any time any appropriate action for relief against any private nuisance.

41510 RIGHT OF ENTRY

Right of Entry

For the purpose of enforcing or administering any state or local law, order, regulation, or rule relating to air pollution, the executive officer of the state board or any air pollution control officer having jurisdiction, or an authorized representative of such officer, upon presentation of his credentials or, if necessary under the circumstances, after obtaining an inspection warrant pursuant to Title 13 (commencing with Section 1822.50), Part 3 of the Code of Civil Procedure, shall have the right of entry to any premises on which an air pollution emission source is located for the purpose of inspecting such source, including securing samples of emissions therefrom, or any records required to be maintained in connection therewith by the state board or any district.

Public Nuisances

41700 PUBLIC NUISANCE

Except as otherwise provided in Section 41705, no person shall discharge from any source whatsoever such quantities of air contaminants or other material which cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public, or which endanger the comfort, repose, health, or safety of any such persons or the public, or which cause, or have a natural tendency to cause, injury or damage to business or property.

Ringelmann/ Opacity Standards

41701 RINGELMANN/OPACITY STANDARDS

Except as otherwise provided in Section 41704, or Article 2 (commencing with Section 41800) of this chapter other than Section 41812, or Article 2 (commencing with Section 42350) of Chapter 4, no person shall discharge into the atmosphere from any source whatsoever any air contaminant, other than uncombined water vapor, for a period or periods aggregating more than three minutes in any one hour which is:

(a) As dark or darker in shade as that designated as No. 2 on the Ringelmann Chart, as published by the United States Bureau of Mines; or,

(b) Of such opacity as to obscure an observer's view to a degree equal to or greater than does smoke described in subdivision (a).

Districts' Permitting System

42300 DISTRICT PERMIT SYSTEM

(a) Every district board may establish, by regulation, a permit system that requires, except as otherwise provided in Section 42310, that before any person builds, erects, alters, replaces, operates, or uses any article, machine, equipment, or other contrivance which may cause the issuance of air contaminants, the person obtain a permit to do so from the air pollution control officer of the district.

Permits

(b) The regulations may provide that a permit shall be valid only for a specified period. However, the expiration date of any permit shall be eligible for extension upon completion of the annual review required pursuant to subdivision (e) of Section 42301 and payment of the fees required pursuant to Section 42311, unless the air pollution control officer or the hearing board has initiated action to suspend or revoke the permit pursuant to Section 42304, 42307, or 42309, that action has resulted in a final determination by the officer or the board to suspend or revoke the permit, and all appeals have been exhausted or the time for appeals from that final determination has been exhausted.

(c) The annual extension of a permit's expiration date pursuant to subdivision (b) does not constitute permit issuance, renewal, reopening, amendment, or any other action subject to the requirements specified in Title V.

42301 REQUIREMENTS FOR PERMIT ISSUANCE

Permit Issuance

A permit system established pursuant to Section 42300 shall do all of the following:

(a) Ensure that the article, machine, equipment, or contrivance for which the permit was issued does not prevent or interfere with the attainment or maintenance of any applicable air quality standard.

(b) Prohibit the issuance of a permit unless the air pollution control officer is satisfied, on the basis of criteria adopted by the district board, that the article, machine, equipment, or contrivance will comply with all of the following:

(1) All applicable orders, rules, and regulations of the district and of the state board.

(2) All applicable provisions of this division.

(c) Prohibit the issuance of a permit to a Title V source if the Administrator of the Environmental Protection Agency objects to its issuance in a timely manner as provided in Title V. This subdivision is not intended to provide any authority to the Environmental Protection Agency to object to the issuance of a permit other than that authority expressly granted by Title V.

(d) Provide that the air pollution control officer may issue to a Title V source a permit to operate or use if the owner or operator of the Title V source presents a variance exempting the owner or operator from Section 41701, any rule or

Permit Issuance

regulation of the district, or any permit condition imposed pursuant to this section, or presents an abatement order that has the effect of a variance and that meets all of the requirements of this part pertaining to variances, and the requirements for the issuance of permits to operate are otherwise satisfied. The issuance of any variance or abatement order is a matter or state law and procedure only and does not amend a Title V permit in any way. Those terms and conditions of any variance or abatement order that prescribe a compliance schedule may be incorporated into the permit consistent with Title V and this division.

(e) Require, upon annual renewal, that each permit be reviewed to determine that the permit conditions are adequate to ensure compliance with, and the enforceability of, district rules and regulations applicable to the article, machine, equipment, or contrivance for which the permit was issued which were in effect at the time the permit was issued or modified, or which have subsequently been adopted and made retroactively applicable to an existing article, machine, equipment, or contrivance, by the district board and, if the permit conditions are not consistent, require that the permit be revised to specify the permit conditions in accordance with all applicable rules and regulations.

(f) Provide for the reissuance or transfer of a permit to a new owner or operator of an article, machine, equipment, or contrivance. An application for transfer of ownership only, or change in operator only, of any article, machine, equipment, or contrivance which had a valid permit to operate within the two-year period immediately preceding the application is a temporary permit to operate. Issuance of the final permit to operate shall be conditional upon a determination by the district that the criteria specified in subdivisions (b) and (e) are met, if the permit was not surrendered as a condition to receiving emission reduction credits pursuant to banking or permitting rules of the district. However, under no circumstances shall the criteria specify that a change of ownership or operator alone is a basis for requiring more stringent emission controls or operating conditions than would otherwise apply to the article, machine, equipment, or contrivance.

Disclosing Information

42303 INFORMATION DISCLOSURE

An air pollution control officer, at any time, may require from an applicant for, or the holder of, any permit provided for by the regulations of the district board, such information, analyses, plans, or specifications which will disclose the nature, extent, quantity, or degree of air contaminants which are, or may be, discharged by the source for which the permit was issued or applied.

42303.5 FALSE STATEMENTS

False Statements

No person shall knowingly make any false statement in any application for a permit, or in any information, analyses, plans, or specifications submitted in conjunction with the application or at the request of the air pollution control officer.

42304 FAILURE TO SUPPLY INFORMATION

Supplying Information

If, within a reasonable time, the holder of any permit issued by a district board willfully fails and refuses to furnish the information, analyses, plans, or specifications requested by the district air pollution control officer, such officer may suspend the permit. Such officer shall serve notice in writing of such suspension and the reasons therefore on the permittee.

42350 APPLICATIONS FOR VARIANCE

Applying for Variances

(a) Any person may apply to the hearing board for a variance from Section 41701 or from the rules and regulations of the district.

(b) (1) If the district board has established a permit system by regulation pursuant to Section 42300, a variance, or an abatement order which has the effect of a variance, may not be granted from the requirement for a permit to build, erect, alter, or replace.

(2) Title V sources shall not be granted a variance, or an abatement order which has the effect of a variance, from the requirement for a permit to operate or use.

(3) In districts with emission-capped trading programs, no variance shall be granted from the emission cap requirement.

42351 INTERIM VARIANCE APPLICATIONS

Interim Variances

(a) Any person who has submitted an application for a variance and who desires to commence or continue operation pending the decision of the hearing board on the application, may submit an application for an interim variance.

(b) An interim variance may be granted for good causes stated in the order granting such a variance. The interim variance shall not be valid beyond the date of decision of the hearing board on the application of the variance or for more than 90 days from date of issuance of the interim variance, whichever occurs first.

(c) The hearing board shall not grant any interim variance (1) after it has held a hearing in compliance with the requirements of Section 40826, or (2) which is being sought to avoid the notice and hearing requirements of Section 40826.

42351.5 INTERIM SCHEDULE MODIFICATION

Interim Schedules

If a person granted a variance with a schedule of increments of progress files an application for modification of the schedule and is unable to notify the hearing board sufficiently in advance to allow the hearing board to schedule a public hearing on the application, the hearing board may grant no more than one interim authorization valid for not more than 30 days, to that person to continue operation pending the decision of the hearing board on the application. In districts with a population of less than 750,000, the chairman of the hearing board or any other member designated by the board may hear the application. If any member of the public contests such a decision made by a single member of the hearing board, the application shall be reheard by the full hearing board within 10 days of the decision. The interim authorization shall not be granted for a requested extension of a final compliance date or where the original variance expressly required advance application for the modification of an increment of progress.

42352 VARIANCE ISSUANCE REQUIREMENTS

Variance Requirements

(a) No variance shall be granted unless the hearing board makes all of the following findings:

(1) That the petitioner for a variance is, or will be, in violation of Section 41701 or of any rule, regulation, or order of the district.

(2) That, due to conditions beyond the reasonable control of the petitioner, requiring compliance would result in either (A) an arbitrary or unreasonable taking of property, or (B) the practical closing and elimination of a lawful business. In making those findings where the petitioner is a public agency, the hearing board shall consider whether or not requiring immediate compliance would impose an unreasonable burden upon an essential public service. For purposes of

Variance Requirements

this paragraph, "essential public service" means a prison, detention facility, police or fire fighting facility, school, health care facility, landfill gas control or processing facility, sewage treatment works, or water delivery operation, if owned and operated by a public agency.

(3) That the closing or taking would be without a corresponding benefit in reducing air contaminants.

(4) That the applicant for the variance has given consideration to curtailing operations of the source in lieu of obtaining a variance.

(5) During the period the variance is in effect, that the applicant will reduce excess emissions to the maximum extent feasible.

(6) During the period the variance is in effect, that the applicant will monitor or otherwise quantify emission levels from the source, if requested to do so by the district, and report these emission levels to the district pursuant to a schedule established by the district.

(b) As used in this section, "public agency" means any state agency, board, or commission, any county, city and county, city, regional agency, public district, or other political subdivision.

42353 OTHER REQUIREMENTS

Other Necessary Requirements

Upon making the specific findings set forth in Section 42352, the hearing board shall prescribe requirements other than those imposed by statute or by any rule, regulation, or order of the district board, not more onerous, applicable to plants and equipment operated by specified industry or business or for specified activity, or to the operations of individual persons. However, no variance shall be granted if the operator, under the variance, will result in a violation of Section 41700.

42354 PRESCRIBING REQUIREMENTS

Prescribing Requirements

In prescribing other and different requirements, in accordance with Section 42353, the hearing board, insofar as is consonant with the Legislature's declarations in Sections 39000 and 39001, shall exercise a wide discretion in weighing the equities involved and the advantages to the residents of the district from the reduction of air contaminants and the disadvantages to any otherwise lawful business, occupation, or activity involved, resulting from requiring compliance with such requirements.

42355 HEARING BOARD BOND REQUIREMENTS

Bond Requirements

(a) The hearing board may require, as a condition of granting a variance, that a bond be posted by the party to whom the variance was granted to assure performance of any construction, alteration, repair, or other work required by the terms and conditions of the variance. The bond may provide that, if the party granted the variance fails to perform the work by the agreed date, the bond shall be forfeited to the district having jurisdiction, or the sureties shall have the option of promptly remedying the variance default or paying to the district an amount, up to the amount specified in the bond, that is necessary to accomplish the work specified as a condition of the variance.

(b) The provisions of this section do not apply to vessels so long as the vessels are not operating in violation of any federal law enacted for the purpose of controlling emissions from combustion of vessel fuels.

Variance Modification

42356 HEARING BOARD VARIANCE MODIFICATION

The hearing board may modify or revoke, by written order, any order permitting a variance.

42357 HEARING BOARD REVIEW OF SCHEDULE

Schedule Review

The hearing board may review and for good cause, such as a change in the availability of materials, equipment, or adequate technology, modify a schedule of increments of progress or a final compliance date in such a schedule.

42358 EFFECTIVE PERIOD OF ORDER

Period of Order

(a) The hearing board, in making any order permitting a variance, shall specify the time during which such order shall be effective, in no event, except as otherwise provided in subdivision (b), to exceed one year, and shall set up a final compliance date.

(b) A variance may be issued for a period exceeding one year if the variance includes a schedule of increments of progress specifying a final compliance date by which the emissions of air contaminants of a source for which the variance is granted will be brought into compliance with applicable emission standards.

Requirements

42359 PUBLIC HEARING REQUIREMENTS

Except in the case of an emergency, as determined by the hearing board, the hearing board shall hold a hearing pursuant to Chapter 8 (commencing with Section 40800) of Part 3 to determine under what conditions, and to what extent, a variance shall be granted.

Emergency Variances

42359.5 EMERGENCY VARIANCES

(a) Notwithstanding any other provisions of this article or of Article 2 (commencing with Section 40820) of Chapter 8 of Part 3, the Chairman of a district hearing board, or any other member of the hearing board designated thereby, may issue, without notice and hearing, an emergency variance to an applicant.

(b) An emergency variance may be issued for good cause, including, but not limited to, a breakdown condition. The district board in consultation with its air pollution control officer and the hearing board may adopt rules and regulations, not inconsistent with this subdivision, to further specify the conditions, and to what extent, an emergency variance may be granted. The emergency variance shall not remain in effect longer than 30 days and shall not be granted when sought to avoid the provisions of Section 40824 or 42351.

Copy to ARB

42360 COPY OF VARIANCE ORDER TO ARB

Within 30 days of any order granting, modifying, or otherwise affecting a variance by the hearing board, or a member thereof pursuant to Section 42359.5, either the air pollution control officer or the hearing board shall submit a copy of the order to the state board.

Validity of Time

42361 VALIDITY OF VARIANCE TIME

Any variance granted by the hearing board of a county district or a unified district, or any member of such a hearing board pursuant to Section 42359.5, applicable in an area which subsequently becomes included within a regional district, including the bay district, shall remain valid for the time specified therein or for one year, whichever is shorter, or, unless prior to the expiration of such time, the hearing board of the regional district modifies or revokes the variance.

Revocation/ Modification

42362 VARIANCE REVOCATION OR MODIFICATION

The state board may revoke or modify any variance granted by any district if, in its judgment, the variance does not require compliance with a required schedule of increments of progress or emission standards as expeditiously as practicable, or the variance does not meet the requirements of this article.

ARB Hearing

42363 ARB HEARING PRIOR TO ACTION

Prior to revoking or modifying a variance pursuant to Section 42362, the state board shall conduct a hearing pursuant to Chapter 8 (commencing with Section 40800) of Part 3 on the matter. The person to whom the variance was granted shall be given immediate notice of any such hearing by the hearing board, and shall be afforded an opportunity to appear at the hearing, to call and examine witnesses, and to otherwise partake as if he were a party to the hearing.

Fee Schedule

42364 SCHEDULE OF FEES

(a) The district board may adopt, by regulation, a schedule of fees which will yield a sum not exceeding the estimated cost of the administration of this article and for the filing of applications for variances or to revoke or modify variances. All applicants shall pay the fees required by the schedule, including, nonwithstanding the provisions of Section 6103 of the Government Code, an applicant that is a publicly owned public utility.

(b) All such fees shall be paid to the district treasurer to the credit of the district.

Criminal Violations

42400 GENERAL VIOLATIONS, CRIMINAL

(a) Except as otherwise provided in Section 42400.1, 42400.2, or 42400.3, or 42400.4 who violates this part, or any rule, regulation, permit, or order of the state board or of a district, including a district hearing board, adopted pursuant to Part 1 (commencing with Section 39000) to Part 4 (commencing with Section 41500), inclusive, is guilty of a misdemeanor and is subject to a fine of not more than one thousand dollars ($1,000) or imprisonment in the county jail for not more than six months, or both.

Criminal Violations

(b) If a violation under subdivision (a) with regard to the failure to operate a vapor recovery system on a gasoline cargo tank is directly caused by the actions of an employee under the supervision of, or of any independent contractor working for, any person subject to this part, the employee or independent contractor, as the case may be, causing the violation is guilty of a misdemeanor and is punishable as provided in subdivision (a). That liability shall not extend to the person employing the employee or retaining the independent contractor, unless that person is separately guilty of an action that violates this part.

(c) (1) Any person who knowingly violates any rule, regulation, permit, order, fee requirement, or filing requirement of the state board or of a district, including a district hearing board, that is adopted for the control of toxic air contaminants pursuant to Part 1 (commencing with Section 39000) to Part 4 (commencing with Section 41500), inclusive, and for which delegation or approval of implementation and enforcement authority has been obtained pursuant to subdivision (1) of Section 112 of the Clean Air Act (42 U.S.C. Sec. 7412(1)), or the regulations adopted pursuant thereto, is guilty of a misdemeanor and is subject to a fine of not more than ten thousand dollars ($10,000) or imprisonment in the county jail for not more than six months, or both.

(2) Any person who knowingly makes any false material statement, representation, or certification in any form or in any notice or report required by a rule or regulation adopted or permit issued for the control of toxic air contaminants pursuant to Part 1 (commencing with Section 39000) to Part 4 (commencing with Section 41500), inclusive, and for which delegation or approval of implementation and enforcement authority has been obtained pursuant to subdivision (1) of Section 112 of the Clean Air Act (42 U.S.C. Sec. 7412(1)), or the regulations adopted pursuant thereto, or who knowingly renders inaccurate any monitoring device required by that toxic air contaminant rule, regulation, or permit is guilty of a misdemeanor and is subject to a fine of not more than ten thousand dollars ($10,000) or imprisonment in the county jail for not more than six months, or both.

(3) Paragraphs (1) and (2) apply only to violations that are not otherwise subject to a fine of ten thousand dollars ($10,000) or more pursuant to Section 42400.1, 42400.2, or 42400.3.

(d) The recovery of civil penalties pursuant to Section 42402, 42402.1, 42402.2, or 42402.3 precludes prosecution pursuant to this section for the same offense. When a district refers a violation to a prosecuting agency, the filing of a criminal complaint is grounds requiring the dismissal of any civil action brought pursuant to this article for the same offense.

(e) Each day during any portion of which a violation of subdivision (a) or (c) occurs is a separate offense.

Criminal Negligence

42400.1 NEGLIGENCE, CRIMINAL

(a) Any person who negligently emits an air contaminant in violation of any provision of this part or any rule, regulation, permit, or order of the state board or of a district pertaining to emission regulations or limitations is guilty of a misdemeanor and is subject to a fine of not more than fifteen thousand dollars ($15,000) or imprisonment in the county jail for not more than nine months, or both.

(b) Any person who owns or operates any source of air contaminant in violation of Section 41700 which causes actual injury, as defined in paragraph (2) or subdivision (d) of Section 42400.2, to the health or safety of a considerable number of persons or the public is guilty of a misdemeanor and is punishable as provided in subdivision (a).

(c) Each day during any portion of which a violation occurs is a separate offense.

(d) The recovery of civil penalties pursuant to Section 42402, 42402.1, 42402.1, or 42402.3, precludes prosecution pursuant to this section for the same offense. When a district refers a violation to a prosecuting agency, the filing of a criminal complaint is grounds requiring the dismissal of any civil action brought pursuant to this article for the same offense.

Criminal Document Falsification

42400.2 DOCUMENT FALSIFICATION, CRIMINAL

(a) Any person who emits an air contaminant in violation of any provision of this part, or any order, rule, regulation, or permit of the state board or of a district pertaining to emission regulations or limitations, and who knew of the emission and failed to take corrective action within a reasonable period of time under the circumstances, is guilty of a misdemeanor and is subject to a fine of not more than twenty-five thousand dollars ($25,000) or imprisonment in the county jail for not more than one year, or both.

(b) For purposes of this section, "corrective action" means the termination of the emission violation or the grant of a variance from the applicable order, rule, regulation, or permit pursuant to Article 2 (commencing with Section 42350). If a district regulation regarding process upsets or equipment breakdowns would allow continued operation of equipment which is emitting air contaminants in excess of allowable limits, compliance with that regulation is deemed to be corrective action.

Document Falsification

(c) Any person who, knowingly and with intent to deceive, falsifies any document required to be kept pursuant to any provision of this part, or any rule, regulation, permit, notice to comply, or order of the state board or of a district, is guilty of a misdemeanor and is punishable as provided in subdivision (a).

(d) (1) Any person who owns or operates any source of air contaminants in violation of Section 41700 which causes actual injury to the health or safety of a considerable number of persons or the public, and who knew of the emission and failed to take corrective action within a reasonable period of time under the circumstances, is guilty of a misdemeanor and is punishable as provided in subdivision (a).

(2) As used in this subdivision, "actual injury" means any physical injury which, in the opinion of a licensed physician and surgeon, requires medical treatment involving more than a physical examination.

(e) Each day during any portion of which a violation occurs constitutes a separate offense.

(f) The recovery of civil penalties pursuant to Section 42402, 42402.1, 422402.2, or 42402.3 precludes prosecution pursuant to this section for the same offense. When a district refers a violation to a prosecuting agency, the filing of a criminal complaint is grounds requiring the dismissal of any civil action brought pursuant to this article for the same offense.

42400.3 WILLFULLY EMITTING AN AIR CONTAMINANT

Willfully Emitting an Air Contaminant

(a) Any person who willfully and intentionally emits an air contaminant in violation of any provision of this part or any rule, regulation, permit, or order of the state board or of a district, pertaining to emission regulations or limitations is guilty of a misdemeanor and is subject to a fine of not more than fifty thousand dollars ($50,000) or imprisonment in the county jail for not more than one year, or both.

(b) The recovery of civil penalties pursuant to Section 42402, 42402.1, 42402.2, or 42402.3, precludes prosecution pursuant to this section for the same offense. When a district refers a violation to a prosecuting agency, the filing of a criminal complaint is grounds requiring the dismissal of any civil action brought pursuant to this article for the same offense.

(c) Each day during any portion of which a violation occurs constitutes a separate offense.

Civil Order of Abatement

42401 VIOLATING ORDER OF ABATEMENT, CIVIL

Any person who intentionally or negligently violates any order of abatement issued by a district pursuant to Section 42450, by a hearing board pursuant to Section 42451, or by the state board pursuant to Section 41505 is liable for a civil penalty of not more than twenty-five thousand dollars ($25,000) for each day in which the violation occurs.

Civil Violations

42402 GENERAL VIOLATIONS, CIVIL

(a) Except as otherwise provided in subdivision (b) or in Section 42402.1, 42402.2, or 42402.3, any person who violates this part, any order issued pursuant to Section 42316, or any rule, regulation, permit, or order of a district, including a district hearing board, or of the state board issued pursuant to Part 1 (commencing with Section 39000) to Part 4 (commencing with Section 41500), inclusive, is strictly liable for a civil penalty of not more than one thousand dollars ($1,000).

(b) (1) Any person who violates any provision of this part, any order issued pursuant to Section 42316, or any rule, regulation, permit, or order of a district, including a district hearing board, or of the state board issued pursuant to Part 1 (commencing with Section 39000) to Part 4 (commencing with Section 41500), inclusive, is strictly liable for a civil penalty of not more than ten thousand dollars ($10,000).

(2) (A) If a civil penalty in excess of one thousand dollars ($1,000) for each day in which the violation occurs is sought, there is no liability under this subdivision if the person accused of the violation alleges by affirmative defense and establishes that the violation was caused by an act which was not the result of intentional or negligent conduct.

Civil Violations

(B) Subparagraph (A) does not apply to a violation of federally enforceable requirements that occur at a Title V source in a district in which a Title V permit program has been fully approved.

(C) Subparagraph (A) does not apply to a person who is determined to have violated an annual facility emissions cap established pursuant to a market-based incentive program adopted by a district pursuant to subdivision (b) of Section 39616.

(c) Each day during any portion of which a violation occurs is a separate offense.

42402.1 NEGLIGENCE OR ACTUAL INJURY, CIVIL

Civil Negligence or Injury

(a) Any person who negligently emits an air contaminant in violation of this part or any rule, regulation, permit, or order of the state board or of a district pertaining to emission regulations or limitations is liable for a civil penalty of not more than fifteen thousand dollars ($15,000).

(b) Any person who owns or operates any source of air contaminants in violation of Section 41700 which causes actual injury, as defined in paragraph (2) of subdivision (d) of Section 42400.2, to the health or safety of a considerable number of persons or the public is liable for a civil penalty as provided in subdivision (a).

(c) Each day during any portion of which a violation occurs is a separate offense.

42402.2 DOCUMENT FALSIFICATION, CIVIL

Civil Document Falsification

(a) Any person who emits an air contaminant in violation of any provision of this part, or any order, rule, regulation, or permit of the state board or of a district pertaining to emission regulations or limitations, and who knew of the emission and failed to take corrective action, as defined in subdivision (b) of Section 42400.2, within a reasonable period of time under the circumstances, is liable for a civil penalty, of not more than twenty-five thousand dollars ($25,000).

(b) Any person who, knowingly and with intent to deceive, falsifies any document required to be kept pursuant to any provision of this part, or any rule, regulation, permit, or order of the state board or of a district, is subject to the same civil penalty as provided in subdivision (a).

(c) Any person who owns or operates any source of air contaminants in violation of Section 41700 which causes actual injury, as defined in paragraph (2) or subdivision (d) of Section 42400.2, to the health or safety of a considerable number of persons or the public, and who knew of the emission and failed to take corrective action, as defined in subdivision (b), of Section 42400.2, within a reasonable period of time under the circumstances, is subject to a civil penalty as provided in subdivision (a).

(d) Each day during any portion of which a violation occurs is a separate offense.

42402.3 CIVIL PENALTIES

Civil Penalties

Any person who willfully and intentionally emits an air contaminant in violation of any provision of this part or any order, permit, rule, or regulation of the state board, or of a district, pertaining to emission regulations or limitations, is liable for a civil penalty of not more than fifty thousand dollars ($50,000).

42402.5 ADMINISTRATIVE PENALTIES

Administrative Penalties

In addition to any civil and criminal penalties prescribed under this article, a district may impose administrative civil penalties for a violation of this part, or any order, permit, rule, or regulation of the state board or of a district, including a district hearing board, adopted pursuant to Part 1 (commencing with Section 39000) to Part 4 (commencing with Section 41500), inclusive, if the district board has adopted rules and regulations specifying procedures for the imposition and amounts of these penalties. No administrative civil penalty levied pursuant to this section may exceed five hundred dollars ($500) for each violation. However, nothing in this section is intended to restrict the authority of a district to negotiate mutual settlements under any other penalty provisions of law which exceeds five hundred dollars ($500).

42403 RECOVERY OF CIVIL PENALTIES

Civil Penalties

(a) The civil penalties prescribed in Sections 39674, 42401, 42402, 42402.1, 42402.2, and 42402.3 shall be assessed and recovered in a civil action brought in the name of the people of the State of California by the Attorney General, by any district attorney, or by the attorney for any district in which the violation occurs in any court of competent jurisdiction.

Civil Penalties

(b) In determining the amount assessed, the court, or in reaching any settlement, the district, shall take into consideration all relevant circumstances, including, but not limited to, the following:

(1) The extent of harm caused by the violation.

(2) The nature and persistence of the violation.

(3) The length of time over which the violation occurs.

(4) The frequency of past violations.

(5) The record of maintenance.

(6) The unproved or innovative nature of the control equipment.

(7) Any action taken by the defendant, including the nature, extent, and time of response of the cleanup and construction undertaken, to mitigate the violation.

(8) The financial burden to the defendant.

Statute of Limitations

42404.5 STATUTE OF LIMITATIONS FOR CIVIL ACTIONS

Any limitation of time applicable to actions brought pursuant to Section 42403 shall not commence to run until the offense has been discovered, or could reasonably have been discovered.

Orders of Abatement

42450 ORDERS OF ABATEMENT

The district board may, after notice and a hearing, issue an order for abatement whenever it finds that any person is constructing or operating any article, machine, equipment, or other contrivance without a permit required by this part, or is in violation of Section 41700 or 41701 or of any order, rule, or regulation prohibiting or limiting the discharge of air contaminants into the air.

In holding such a hearing, the district board shall be vested with all the powers and duties of the hearing board. Notice shall be given, and the hearing shall be held, pursuant to Chapter 8 (commencing with Section 40800) of Part 3.

Monitoring Devices

42700 MONITORING DEVICES

(a) The Legislature hereby finds and declares that stationary sources of air pollution are known to emit significant amounts of pollutants into the air, but that existing sampling techniques are not sufficiently precise to permit accurate measurement. The Legislature further finds and declares that more accurate data will improve the design of strategies for the control of pollutants in the most cost-effective manner.

(b) The Legislature further finds and declares that public complaints about excessive emissions from stationary sources are difficult or impossible to evaluate in the absence of adequate means of monitoring emissions on a continuing basis. The Legislature further finds and declares that, although the state board and the districts are authorized under Sections 41511 and 42303 to require stationary sources of air contaminants to install and operate monitoring devices to measure and record continuously the emissions concentration and amount of any specified pollutant, many districts have failed to exercise that authority.

(c) The Legislature further finds and declares that all districts, especially the bay district, the districts located, in whole or part, within the South Coast Air Basin, and the San Diego County Air Pollution Control District, should be encouraged to require that monitoring devices be installed in each stationary source of air contaminants that emits into the atmosphere 100 tons or more each year of nonmethane hydrocarbons, oxides of nitrogen, oxides of sulfur, reduced sulfur compounds, or particulate matter or 1,000 tons or more each year of carbon monoxide.

(d) The Legislature further finds and declares that, pursuant to Section 39616, the south coast district has required the installation of a substantial number of monitoring devices and the installation and use of strip chart recorders for compliance purposes. However, electronic or computer data capture and storage is generally less costly and may have the capability to provide greater data availability with the same degree of security.

(e) To encourage the districts to take actions to monitor emissions of stationary sources as described in this section, the state board shall determine the availability, technological feasibility, and economic reasonableness of monitoring devices for those stationary sources as provided by Section 42701.

(f) To make emissions data available to the public and to minimize burdens on the private sector, the districts shall allow stationary sources the option of using electronic or computer data storage for purposes of compliance with Section 39616.

Feasibility

42701 AVAILABILITY, FEASIBILITY

(a) For the purposes of Sections 41511 and 42303, the state board shall determine the availability, technological feasibility, and economic reasonableness of monitoring devices to measure and record continuously the emissions concentration and amount of nonmethane hydrocarbons, oxides of nitrogen, oxides of sulfur, reduced sulfur compounds, particulate matter, and carbon monoxide emitted by stationary sources. Such determination shall be made for stationary sources which emit such contaminants in the quantities set forth in Section 42700, and may be made for stationary sources which emit lesser amounts. The state board shall complete an initial review of submitted devices by June 1, 1975.

Process Specification

42702 SPECIFICATION OF PROCESSES

The state board shall specify the types of stationary sources, processes, and the contaminants, or combinations thereof, for which a monitoring device is available, technologically feasible, and economically reasonable. Such specification may be by any technologically based classification, including on an industrywide basis or by individual stationary source, by air basin, by district, or any other reasonable classification.

Testing Expenses

42703 REIMBURSEMENTS FOR TESTING EXPENSES

The state board shall require the manufacturer of any monitoring device submitted for a determination to reimburse the state board for its actual expenses incurred in making the determination, including, where applicable, its contract expenses for testing and review.

Availability

42704 DETERMINATION OF AVAILABILITY

After the state board has made a determination of availability, the state board may, as appropriate, revoke or modify its prior determination of availability if circumstances beyond the control of the state board, or of a stationary source required to install a monitoring device, cause a substantial delay or impairment in the availability of the device or cause the device no longer to be available.

600 LEGAL REQUIREMENTS

Records

42705 RECORDS

Any stationary source required by the district in which the source is located to install and operate a monitoring device shall retain the records from the device for not less than two years and, upon request, shall make the records available to the state board and the district. The district shall allow the source the option of using electronic or computer data storage, as defined in Section 40407.5 and consistent with Section 40440.3, as a method of record retention. The source shall not be limited solely to the installation or maintenance of strip chart recorders.

Reporting Violations

42706 REPORT OF VIOLATION

Any violation of any emission standard to which the stationary source is required to conform, as indicated by the records of the monitoring device, shall be reported by the operator of the source to the district within 96 hours after such occurrence. The district shall, in turn, report the violation to the state board within five working days after receiving the report of the violation from the operator.

Fees/ Inspection

42707 INSPECTION; FEES

The air pollution control officer shall inspect, as he/she determines necessary, the monitoring devices installed in every stationary source of air contaminants located within his jurisdiction required to have such devices to insure that such devices are functioning properly. The district may require reasonable fees to be paid by the operator of any such source to cover the expense of such inspection and other costs related thereto.

Local Authority

42708 POWERS OF LOCAL OR REGIONAL AUTHORITY

This chapter shall not prevent any local or regional authority from adopting monitoring requirements more stringent than those set forth in this chapter or be construed as requiring the installation of monitoring devices on any stationary source or classes of stationary sources. This section shall not limit the authority of the state board to require the installation of monitoring devices pursuant to Chapter 1 (commencing with Section 41500).

605 DISTRICT RULES

District Rules

Each local APCD/AQMD has prohibitory rules that govern basic operations of any stationary source that emits air pollutants. The majority of PRF facilities are located in the Bay Area Air Quality Management District (BAAQMD), the San Diego Air Pollution Control District (SDCAPCD), the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD), the South Coast Air Quality Management District (SCAQMD), and the Ventura County Air Pollution Control District (VCAPCD). The district rules affecting PRF facilities are discussed in great detail in Chapter 300, Table 300.7: Polyester Resin Operations Rule/ Measure/Date Performance Standards for California.

606 ENFORCEMENT

Enforcement

After a Permit to Operate is issued, the APCD/AQMD or (district) enforcement staff will inspect the facility periodically to determine compliance. A significant portion of the compliance determination is usually based on comparing operating conditions included in the Permit to Operate with the status of the permitted equipment. Permits have conditions which help ensure compliance with district rules and regulations.

District enforcement staff may also perform a source test to determine compliance with emission limits. Rule violations documented by enforcement staff either by source test or other means may be subject to civil and criminal penalties and fines up to $50,000 per day. A criminal violation could result in imprisonment for up to one year.

607 SUMMARY OF APPLICABLE FEDERAL STATUTES AND REGULATIONS

Federal Statutes/ Regulations

This section discusses the Federal regulations that may apply to this sector. The purpose of this section is to highlight and briefly describe the applicable Federal requirements, and to provide citations for more detailed information. The three following sections are included:

Federal Regulations

1) Section 607.1 contains a general overview of major statutes;
2) Section 607.2 contains a list of regulations specific to this industry; and,
3) Section 607.3 contains a list of pending and proposed regulations.

The descriptions within Section 607 are intended solely for general information. Depending upon the nature or scope of the activities at a particular facility, these summaries may or may not necessarily describe all applicable environmental requirements. Moreover, they do not constitute formal interpretations or clarifications of the statutes and regulations. For further information, readers should consult the Code of Federal Regulations and other state or local regulatory agencies. EPA Hotline contacts are also provided for each major statute.

Resource Conservation & Recovery Act (RCRA)

607.1 GENERAL DESCRIPTION OF MAJOR STATUTES

607.1.1 Resource Conservation and Recovery Act

The Resources Conservation And Recovery Act (RCRA) of 1976 which amended the Solid Waste Disposal Act, addresses solid (Subtitle D) and hazardous (Subtitle C) waste management activities. The Hazardous and Solid Waste Amendments (HSWA) of 1984 strengthened RCRA's waste management provisions and added Subtitle I, which governs underground storage tanks (USTs).

Regulations promulgated pursuant to Subtitle C of RCRA (40 CFR Parts 260-299) establish a "cradle-to-grave" system governing hazardous waste from the point of generation to disposal. RCRA hazardous wastes include the specific materials listed in the regulations (commercial chemical products, designated with the code ""P" or "U"; hazardous wastes from specific industries/sources, designated with the code "K"; or hazardous wastes from nonspecific sources, designated with the code "F") or materials which exhibit a hazardous waste characteristic (ignitability, corrosivity, reactivity, or toxicity and designated with the code "D").

Regulated entities that generate hazardous waste are subject to waste accumulation, manifesting, and record keeping standards. Facilities must obtain a permit either from EPA or from a State agency which EPA has authorized to implement the permitting program if they store hazardous wastes for more than 90 days before treatment or disposal. Facilities may treat hazardous wastes stored in less-than-ninety-day tanks or containers without a permit. Subtitle C permits contain general facility standards such as contingency plans, emergency proce-

RCRA

dures, record keeping and reporting requirements, financial assurance mechanisms, and unit-specific standards. RCRA also contains provisions (40 CFR Part 264 Subpart S and § 264.10) for conducting corrective actions which govern the cleanup of releases of hazardous waste or constituents from solid waste management units at RCRA-regulated facilities.

Although RCRA is a Federal statute, many States implement the RCRA program. Currently, EPA has delegated its authority to implement various provisions of RCRA to 47 of the 50 States and two U.S. Territories. Delegation has not been given to Alaska, Hawaii, or Iowa.

Most RCRA requirements are not industry specific, but apply to any company that generates, transports, treats, stores, or disposes of hazardous waste. Here are some important RCRA regulatory requirements:

RCRA Requirements

1) **Identification of Solid and Hazardous Wastes** (40 CFR Part 261) lays out the procedure every generator must follow to determine whether the material in question is considered a hazardous waste, solid waste, or is exempted from regulation.

2) **Standards for Generators of Hazardous Waste** (40 CFR Part 262) establishes the responsibilities of hazardous waste generators including obtaining an EPA ID number, preparing a manifest, ensuring proper packaging and labeling, meeting standards for waste accumulation units, and record keeping and reporting requirements. Generators can accumulate hazardous waste for up to 90 days (or 180 days depending on the amount of waste generated) without obtaining a permit.

3) **Land Disposal Restrictions** (LDRs).(40 CFR Part 268) are regulations prohibiting the disposal of hazardous waste on land without prior treatment. Under the LDRs program, materials must meet LDR treatment standards prior to placement in a RCRA land disposal unit (landfill, land treatment unit, waste pile, or surface impoundment). Generators of waste subject to the LDRs must provide notification of such to the designated TSD facility to ensure proper treatment prior to disposal.

4) **Used Oil Management Standards** (40 CFR Part 279) impose management requirements affecting the storage, transportation, burning, processing, and re-refining of the used oil. For parties that merely generate used oil, regulations

RCRA Requirements

establish storage standards. For a party considered a used oil processor, re-refiner, burner, or marketer (one who generates and sells off-specification used oil), additional tracking and paperwork requirements must be satisfied.

5) RCRA contains unit-specific standards for all units used to store, treat, or dispose of hazardous waste, including **Tanks and Containers.** Tanks and containers used to store hazardous waste with a high volatile organic concentration must meet emission standards under RCRA. Regulations (40 CFR Part 264-2265, Subpart CC) require generators to test the waste to determine the concentration of the waste, to satisfy tank and container emissions standards, and to inspect and monitor regulated units. These regulations apply to all facilities that store such waste, including large quantity generators accumulating waste prior to shipment off-site.

6) **Underground Storage Tanks** (USTs) containing petroleum and hazardous substances are regulated under Subtitle I of RCRA. Subtitle I regulations (40 CFR Part 280) contain tank design and release detection requirements, as well as financial responsibility and corrective action standards for USTs. The UST program also includes upgrade requirements for existing tanks that must be met by December 22, 1998.

7) **Boilers and Industrial Furnaces** (BIFs) that use or burn fuel containing hazardous waste must comply with design and operating standards. BIF regulations (40 CFR Part 266, Subpart H) address unit design, provide performance standards, require emissions monitoring, and restrict the type of waste that may be burned.

EPA's RCRA, Superfund and EPCRA Hotline, *at (800) 424-9346, responds to questions and distributes guidance regarding all RCRA regulations. The RCRA Hotline operates weekdays from 0900 to 1800, ET, excluding Federal holidays.*

607.1.2 Comprehensive Environmental Response, Compensation, and Liability Act

CERCLA

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a 1980 law known commonly as Superfund, authorizes EPA to respond to releases, or threatened releases, of hazardous substances that may endanger public health, welfare, or the environment. CERCLA also enables EPA to force parties responsible for environmental contamination to clean it up or to reimburse the Superfund for response costs incurred by EPA. The Superfund

RCRA Requirements

Amendments and Reauthorization Act (SARA) of 1986 revised various sections of CERCLA, extended the taxing authority for the Superfund, and created a freestanding law, SARA Title III, also known as the Emergency Planning and Community Right-to-Know Act (EPCRA).

The CERCLA hazardous substance release reporting regulations (40 CFR Part 302) direct the person in charge of a facility to report to the National Response Center (NRC) any environmental release of a hazardous substance which equals or exceeds a reportable quantity. Reportable quantities are listed in 40 CFR § 302.4. A release report may trigger a response by EPA, or by one or more Federal or State emergency response authorities.

EPA implements hazardous substance responses according to procedures outlined in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR Part 300). The NCP includes provisions for permanent cleanups, known as remedial actions, and other cleanups referred to as removals. EPA generally takes remedial actions only at sites on the National Priorities List (NPL), which currently includes approximately 1300 sites. Both EPA and states can act at sites; however, EPA provides responsible parties the opportunity to conduct removal and remedial actions and encourages community involvement throughout the Superfund response process.

***EPA's RCRA, Superfund and EPCRA Hotline,** at (800) 424-9346, answers questions and references guidance pertaining to the Superfund program. The CERCLA Hotline operates weekdays from 0900 to 1800, ET, excluding Federal holidays.*

607.1.3 Emergency Planning and Community Right-to-Know Act

Emergency Planning & Community Right-to-Know Act

The Superfund Amendments and Reauthorization Act (SARA) of 1986 created the Emergency Planning and Community Right-to-Know Act (EPCRA, also known as SARA Title III), a statute designed to improve community access to information about chemical hazards and to facilitate the development of chemical emergency response plans by State and local governments. EPCRA required the establishment of State emergency response commissions (SERCs), responsible for coordinating certain emergency response activities and for appointing local emergency planning committees (LEPCs).

600 LEGAL REQUIREMENTS

Emergency Planning & Community Right-to-Know Act

EPCRA and the EPCRA regulations (40 CFR Parts 350-372) establish four types of reporting obligations for facilities which store or manage specified chemicals:

1) **EPCRA § 302** requires facilities to notify the SERC and LEPC of the presence of any extremely hazardous substance (the list of such substances is in 40 CFR Part 355, Appendices A and B) if it has such substance in excess of the substance's threshold planning quantity, and directs the facility to appoint an emergency response coordinator.

2) **EPCRA § 311 and § 312** require a facility at which a hazardous chemical, as defined by the Occupational Safety and Health Act, is present in an amount exceeding a specified threshold to submit to the SERC, LEPC, and local fire department material safety data sheets (MSDSs) or lists of MSDS's and hazardous chemical inventory forms (also known as Tier I and II forms). This information helps the local government respond in the event of a spill or release of the chemical.

3) **EPCRA § 313** requires manufacturing facilities included in SIC codes 20 through 39, which have ten or more employees, and which manufacture, process, or use specified chemicals in amounts greater than threshold quantities, to submit an annual toxic chemical release report. This report, known commonly as the Form R, covers releases and transfers of toxic chemicals to various facilities and environmental media, and allows EPA to compile the national Toxic Release Inventory (TRI) database.

All information submitted pursuant to EPCRA regulations is publicly accessible, unless protected by a trade secret claim.

***EPA's RCRA, Superfund and EPCRA Hotline,** at (800) 424-9346, answers questions and distributes guidance regarding the emergency planning and community right-to-know regulations. The EPCRA Hotline operates weekdays from 0900 to 1800, ET, excluding Federal holidays.*

Clean Water Act

607.1.4 Clean Water Act

The primary objective of the **Federal Water Pollution Control Act,** commonly referred to as the Clean Water Act (CWA), is to restore and maintain the chemical, physical, and biological integrity of the nation's surface waters. Pollutants

Clean Water Act

regulated under the CWA include "priority" pollutants, including various toxic pollutants; "conventional" pollutants, such as biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform, oil and grease, and pH; and "non-conventional" pollutants, including any pollutant not identified as either conventional or priority.

The CWA regulates both direct and indirect discharges. The National Pollutant Discharge Elimination System (NPDES) program (CWA § 502) controls direct discharges into navigable waters. Direct discharges or "point source" discharges are from sources such as pipes and sewers. NPDES permits, issued by either EPA or an authorized State (EPA has authorized 42 States to administer the NPDES program), contain industry-specific, technology-based and/or water quality-based limits, and establish pollutant monitoring requirements. A facility that intends to discharge into the nation's waters must obtain a permit prior to initiating its discharge. A permit applicant must provide quantitative analytical data identifying the types of pollutants present in the facility's effluent. The permit will then set the conditions and effluent limitations on the facility discharges.

A NPDES permit may also include discharge limits based on Federal or State water quality criteria or standards, that were designed to protect designated uses of surface waters, such as supporting aquatic life or recreation. These standards, unlike the technological standards, generally do not take into account technological feasibility or costs. Water quality criteria and standards vary from State to State, and site to site, depending on the use classification of the receiving body of water. Most States follow EPA guidelines which propose aquatic life and human health criteria for many of the 126 priority pollutants.

607.1.5 Storm Water Discharges

Storm Water Discharges

In 1987 the CWA was amended to require EPA to establish a program to address the storm water discharges. In response, EPA promulgated the NPDES storm water permit application regulations. These regulations require that facilities with the following storm water discharges apply for an NPDES permit: (1) a discharge associated with industrial activity; (2) a discharge from a large or medium municipal storm sewer system; or (3) a discharge which EPA or the State determines to contribute to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States.

600 LEGAL REQUIREMENTS

Storm Water Discharges

The term "storm water discharge associated with industrial activity" means a storm water discharge from one of 11 categories of industrial activity defined at 40 CFR 122.26. Six of the categories are defined by SIC codes while the other five are identified through narrative descriptions of the regulated industrial activity. If the primary SIC code of the facility is one of those identified in the regulations, the facility is subject to the storm water permit application requirements. If any activity at a facility is covered by one of the five narrative categories, storm water discharges from those areas where the activities occur are subject to storm water discharge permit application requirements.

Those facilities/activities that are subject to storm water discharge permit application requirements are identified below. To determine whether a particular facility falls within one of these categories, consult the regulation.

Application Requirements

Category i: Facilities subject to storm water effluent guidelines, new source performance standards, or toxic pollutant effluent standards.

Category ii: Facilities classified as SIC 24 - lumber and wood products (except wood kitchen cabinets); SIC 26 - paper and allied products (except paperboard containers and products); SIC 28 - chemicals and allied products (except drugs and paints); SIC 291 - petroleum refining; and SIC 311 - leather tanning and finishing, 32 (except 323) - stone, clay, glass, and concrete, 33 - primary metals, 3441 - fabricated structural metal, and 373 - ship and boat building and repairing.

Category iii: Facilities classified as SIC 10 - metal mining; SIC 12 - coal mining; SIC 13 - oil and gas extraction; and SIC 14 - nonmetallic mineral mining.

Category iv: Hazardous waste treatment, storage, or disposal facilities.

Category v: Landfills, land application sites, and open dumps that receive or have received industrial wastes.

Category vi: Facilities classified as SIC 5015 - used motor vehicle parts; and SIC 5093 - automotive scrap and waste material recycling facilities.

Category vii: Steam electric power generating facilities.

Application Requirements

Category viii: Facilities classified as SIC 40 - railroad transportation; SIC 41 - local passenger transportation; SIC 42 - trucking and warehousing (except public warehousing and storage); SIC 43 - U.S. Postal Service; SIC 44 - water transportation; SIC 45 - transportation by air; and SIC 5171 - petroleum bulk storage stations and terminals.

Category ix: Sewage treatment works.

Category x: Construction activities except operations that result in the disturbance of less than five acres of total land area.

Category xi: Facilities classified as SIC 20 - food and kindred products; SIC 21 - tobacco products; SIC 22 - textile mill products; SIC 23 - apparel related products; SIC 2434 - wood kitchen cabinets manufacturing; SIC 25 - furniture and fixtures; SIC 265 - paperboard containers and boxes; SIC 267 - converted paper and paperboard products; SIC 27 - printing, publishing, and allied industries; SIC 283 - drugs; SIC 285 - paints, varnishes, lacquer, enamels, and allied products; SIC 30 - rubber and plastics; SIC 31 - leather and leather products (except leather and tanning and finishing); SIC 323 - glass products; SIC 34 - fabricated metal products (except fabricated structural metal); SIC 35 - industrial and commercial machinery and computer equipment; SIC 36 - electronic and other electrical equipment and components; SIC 37 - transportation equipment (except ship and boat building and repairing); SIC 38 - measuring, analyzing, and controlling instruments; SIC 39 - miscellaneous manufacturing industries; and SIC 4221-4225 - public warehousing and storage.

607.1.6 Pretreatment Program

Pretreatment Program

Another type of discharge that is regulated by the CWA is one that goes to a publicly-owned treatment works (POTWs). The national pretreatment program (CWA § 307(b)) controls the indirect discharge of pollutants to POTWs by "industrial users." Facilities regulated under § 307(b) must meet certain pretreatment standards. The goal of the pretreatment program is to protect municipal wastewater treatment plants from damage that may occur when hazardous, toxic, or other wastes are discharged into a sewer system and to protect the quality of sludge generated by these plants. Discharges to a POTW are regulated primarily by the POTW itself, rather than the State or EPA.

600 LEGAL REQUIREMENTS

Pretreatment Program

EPA has developed technology-based standards for industrial users of POTWs. Different standards apply to existing and new sources within each category. "Categorical" pretreatment standards applicable to an industry on a nationwide basis are developed by EPA. In addition, another kind of pretreatment standard, "local limits," are developed by the POTW in order to assist the POTW in achieving the effluent limitations in its NPDES permit.

Regardless of whether a State is authorized to implement either the NPDES or the pretreatment program, if it develops its own program, it may enforce requirements more stringent than Federal standards.

Spill Prevention, Control & Countermeasure Plans (SPCC)

607.1.7 Spill Prevention, Control and Countermeasure Plans

The 1990 **Oil Pollution Act** requires that facilities that could reasonably be expected to discharge oil in harmful quantities prepare and implement more rigorous **Spill Prevention Control and Countermeasure (SPCC) Plan** required under the CWA (40 CFR § 112.7). There are also criminal and civil penalties for deliberate or negligent spills of oil. Regulations covering response to oil discharges and contingency plans (40 CFR Part 300), and Facility Response Plans to oil discharges (40 CFR § 112.20) and for PCB transformers and PCB-containing items were revised and finalized in 1995.

EPA's Office of Water, *at (202) 260-5700, will direct callers with questions about the CWA to the appropriate EPA office. EPA also maintains a bibliographic database of Office of Water publications which can be accessed through the Ground Water and Drinking Water resource center, at (202) 260-7786.*

Safe Drinking Water Act (SDWA)

607.1.8 Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) mandates that EPA establish regulations to protect human health from contaminants in drinking water. The law authorizes EPA to develop national drinking water standards and to create a joint Federal-State system to ensure compliance with these standards. The SDWA also directs EPA to protect underground sources of drinking water through the control of underground injection of liquid wastes.

EPA has developed primary and secondary drinking water standards under its SDWA authority. EPA and authorized States enforce the primary drinking water standards, which are, contaminant-specific concentration limits that apply to

SDWA

certain public drinking water supplies. Primary drinking water standards consist of maximum contaminant level goals (MCLGs), which are nonenforceable health-based goals, and maximum contaminant levels (MCLs), which are enforceable limits set as close to MCLGs as possible, considering cost and feasibility of attainment.

The **SDWA Underground Injection Control (UIC)** program (40 CFR Parts 144 - 148) is a permit program which protects underground sources of drinking water by regulating five classes of injection wells. UIC permits include design, operating, inspection, and monitoring requirements. Wells used to inject hazardous wastes must also comply with RCRA corrective action standards in order to be granted a RCRA permit, and must meet applicable RCRA land disposal restrictions standards. The UIC permit program is primarily State-enforced, since EPA has authorized all but a few States to administer the program.

The SDWA also provides for a Federally-implemented Sole Source Aquifer program, which prohibits Federal funds from being expended on projects that may contaminate the sole or principal source of drinking water for a given area, and for a State-implemented Wellhead Protection program, designed to protect drinking water wells and drinking water recharge areas.

EPA's Safe Drinking Water Hotline, *at (800) 426-4791, answers questions and distributes guidance pertaining to SDWA standards. The Hotline operates from 0900 to 1730, ET, excluding Federal holidays.*

607.1.9 Toxic Substances Control Act

Toxic Substances Control Act (TSCA)

The Toxic Substances Control Act (TSCA) granted EPA authority to create a regulatory framework to collect data on chemicals in order to evaluate, assess, mitigate, and control risks which may be posed by their manufacture, processing, and use. TSCA provides a variety of control methods to prevent chemicals from posing unreasonable risk.

TSCA standards may apply at any point during a chemical's life cycle. Under TSCA § 5, EPA has established an inventory of chemical substances. If a chemical is not already on the inventory, and has not been excluded by TSCA, a premanufacture notice (PMN) must be submitted to EPA prior to manufacture or import. The PMN must identify the chemical and provide available information on health and environmental effects. If available data are not sufficient to evalu-

TSCA

ate the chemicals effects, EPA can impose restrictions pending the development of information on its health and environmental effects. EPA can also restrict significant new uses of chemicals based upon factors such as the projected volume and use of the chemical.

Under TSCA § 6, EPA can ban the manufacture or distribution in commerce, limit the use, require labeling, or place other restrictions on chemicals that pose unreasonable risks. Among the chemicals EPA regulates under § 6 authority are asbestos, chlorofluorocarbons (CFCs), and polychlorinated biphenyls (PCBs).

EPA's TSCA Assistance Information Service, at (202) 554-1404, answers questions and distributes guidance pertaining to Toxic Substances Control Act standards. The Service operates from 0830 to 1630, ET, excluding Federal holidays.

Clean Air Act (CAA)

607.1.10 Clean Air Act

The Clean Air Act (CAA) and its amendments, including the **Clean Air Act Amendments (CAAA)** of 1990, are designed to "protect and enhance the nation's air resources so as to promote the public health and welfare and the productive capacity of the population." The CAA consists of six sections, known as Titles, which direct EPA to establish national standards for ambient air quality and for EPA and the States to implement, maintain, and enforce these standards through a variety of mechanisms. Under the CAAA, many facilities will be required to obtain permits for the first time. State and local governments oversee, manage, and enforce many of the requirements of the CAAA. CAA regulations appear at 40 CFR Parts 50 - 99.

Pursuant to **Title I of the CAA,** EPA has established national ambient air quality standards (NAAQS) to limit levels of "criteria pollutants," including carbon monoxide, lead, nitrogen dioxide, particulate matter, volatile organic compounds (VOCs), ozone, and sulfur dioxide. Geographic areas that meet NAAQS for a given pollutant are classified as attainment areas; those that do not meet NAAQS are classified as non-attainment areas. Under section 110 of the CAA, each State must develop a State Implementation Plan (SIP) to identify sources of air pollution and to determine what reductions are required to meet Federal air quality standards. Revised NAAQS for particulates and ozone were proposed in 1996 and began to go into effect in late 1997.

New Source Performance Standards (NSPS)

Title I also authorizes EPA to establish New Source Performance Standards (NSPS), which are nationally uniform emission standards for new stationary sources falling within particular industrial categories. NSPS are based on the pollution control technology available to that category of industrial source.

National Emission Standards for Hazardous Air Pollutants (NESHAP)

Hazardous Air Pollutants (HAP)

Under Title I, EPA establishes and enforces **National Emission Standards for Hazardous Air Pollutants (NESHAPs),** nationally uniform standards oriented towards controlling particular **hazardous air pollutants (HAPs).** Title I, Section 112(c) of the CAA further directed EPA to develop a list of sources that emit any of 189 HAPs, and to develop regulations for these categories of sources. To date, EPA has listed 174 categories and developed a schedule for the establishment of emission standards. The emission standards will be developed for both new and existing sources based on "maximum achievable control technology" (MACT). The MACT is defined as the control technology achieving the maximum degree of reduction in the emission of the HAPs, taking into account cost and other factors.

Title II

Title II of the CAA pertains to mobile sources, such as cars, trucks, buses, and planes. Reformulated gasoline, automobile pollution control devices, and vapor recovery nozzles on gas pumps are a few of the mechanisms EPA uses to regulate mobile air emission sources.

Title IV

Title IV of the CAA establishes a sulfur dioxide nitrous oxide emissions program designed to reduce the formation of acid rain. Reduction of sulfur dioxide releases will be obtained by granting to certain sources limited emissions allowances, which, beginning in 1995, will be set below previous levels of sulfur dioxide releases.

Title V

Title V of the CAA of 1990 created a permit program for all "major sources" (and certain other sources) regulated under the CAA. One purpose of the operating permit is to include in a single document all air emissions requirements that apply to a given facility. States are developing the permit programs in accordance with guidance and regulations from EPA. Once a State program is approved by EPA, permits will be issued and monitored by that State.

Title VI

Title VI of the CAA is intended to protect stratospheric ozone by phasing out the manufacture of ozone-depleting chemicals and restrict their use and distribution. Production of Class I substances, including 15 kinds of chlorofluorocarbons (CFCs) and chloroform, were phased out (except for essential uses) in 1996.

600 LEGAL REQUIREMENTS

Hotlines

EPA's Clean Air Technology Center, *at (919) 541-0800, provides general assistance and information on CAA standards.* ***The Stratospheric Ozone Information Hotline,*** *at (800) 296-1966, provides general information about regulations promulgated under Title VI of the CAA, and* ***EPA's EPCRA Hotline,*** *at (800) 535-0202, answers questions about accidental release prevention under CAA § 112(r). In addition, the* ***Clean Air Technology Center's*** *website includes recent CAA rules, EPA guidance documents, and updates of EPA activities (www.epa.gov/ttn then select Directory and then CATC). Also, the* ***California Air Resources Board's (ARB) Compliance Assistance Program (CAP)*** *has available the* ***Toxics Enforcement Manual*** *in two parts. Part B is comprised of individual chapters, each called a "NESHAPS/MACT Guideline Document" that deals with a particular NESHAPS rule. Part A will contain background information on the ARB's and Federal EPA's toxics programs, and will be developed soon. To order a copy of the Toxics Enforcement Manual, please call the CAP at (916) 327-7211, or visit our website at* ***http://inside.arb.ca.gov.***

607.2 INDUSTRY SPECIFIC REQUIREMENTS

Industry Specific Requirements

The plastic resin and manmade fiber industries are affected by nearly all federal environmental statutes. In addition, the industries are subject to numerous laws and regulations from state and local governments designed to protect and improve the nation's health, safety, and environment. A summary of the major federal regulations affecting the plastic resin and manmade fiber industry follows.

607.2.1 Clean Air Act

Clean Air Act (CAA)

The original CAA authorized EPA to set limits on plastic resin and manmade fiber plant emissions. In its new source performance standards, (NSPS) for polymer manufacturing facilities (40 CFR Part 60 Subpart DDD), EPA set minimum standards for the lowest achievable emissions rates (LAER) and best available control technologies (BACT). The NSPS for Polymers requires air emission controls on new and existing facilities that manufacture polypropylene, polyethylene, polystyrene and poly (ethylene and terephthalate). Included are standards on controlling intermittent and continuous sources of emissions from processes. EPA also published an NSPS for synthetic fiber production facilities (40 CFR Part 60 Subpart HHH). The NSPS for Synthetic Fibers regulates VOC emissions from facilities that use solvents in manufacturing fibers. There are additional NSPS that apply to plastic resin and synthetic fiber manufacturers including those for flares (40 CFR Part 60 Subpart A), storage vessels (40 CFR

Part 60 Subpart K), equipment leaks (40 CFR Part 60 Subpart VV), air oxidation processes (40 CFR Part 60 Subpart NNN), and reactor processes (40 CFR Part 60 Subpart RRR).

CAA Amendments

The Clean Air Act Amendments of 1990 set National Emission Standards for Hazardous Air Pollutants (NESHAP) from industrial sources for 41 pollutants to be met by 1995 and for 148 other pollutants to be reached by 2003. Several provisions affect the plastic resin and manmade fiber industries. In April 1994, the EPA published Hazardous Organic National Emissions Standards for Hazardous Air Pollutants, also known as HON, in a rule aimed at reducing air toxics emissions from chemical and allied product plants. This rule, which consists of four subparts, affects hundreds of plastic resin and manmade fiber plants and thousands of chemical process units since potential organic hazardous air pollutants are widely used as reactants. Processes covered include heat exchange systems and maintenance operations (40 CFR Part 63 Subpart F); process vents, storage vessels, transfer operations, and wastewater (40 CFR Part 63 Subpart G); equipment leaks (40 CFR Part 63 Subpart H); and equipment leaks for polycarbonate plants (40 CFR Part 63 Subpart I). Another NESHAP that may affect plastic resin and manmade fiber manufacturers is that for treatment, storage, and disposal facilities (40 Part CFR 63 Subpart AA). The HON also includes innovative provisions such as emissions trading, that offer industry flexibility in complying with the rule's emissions goals.

NESHAPs

Subsets of the plastic resin and manmade fiber industries are regulated under other NESHAPs. EPA published a final rule for epoxy resins and non-nylon polyamide resins in March 1995. The rule was expected to reduce epichlorohydrin emissions from process vents and storage tank emissions. In September 1996, EPA published a final rule for Group I Polymers and Resins (60 FR 46906) under 40 CFR Part 63, Subpart U. This rule focused on reducing emissions from facilities that make certain elastomers used in the manufacture of synthetic rubber products. The rule was expected to reduce emissions of styrene, hexane, toluene, and other toxics. Provisions on pollution prevention, as well as a market-based provision on emissions averaging, were also included in the rule.

In September 1996, EPA also published a final rule for Designated Group IV Polymers and Resins (61 FR 48208) under 40 CFR Part 63, Subpart JJJ. This rule was expected to reduce emissions of air toxics from poly (ethylene terephlate), nitrile, and styrene-based resins facilities. The rule was expected to reduce styrene, butadiene, and methanol emissions from storage vessels, process

NESHAPs

vents, equipment leaks, and wastewater operations. A direct final notice (62 FR 1869) was published on January 14, 1997, which extended the heat exchange system compliance date for the Group I rule and the equipment leak compliance dates for both the Group I and Group IV rules. Other NESHAPs that apply to the industry cover vinyl chloride manufacturers (40 CFR Part 61 Subpart F), benzene equipment leaks (40 CFR Part 61 Subpart J), fugitive emissions (40 CFR Part 61 Subpart V), benzene emissions from benzene storage vessels (40 CFR Part 61 Subpart Y), benzene emissions from benzene transfer operations (40 CFR Part 61 Subpart BB), and benzene waste operations (40 CFR Part 61 Subpart FF).

607.2.2 Clean Water Act

Clean Water Act

The Clean Water Act, first passed in 1972 and amended in 1977 and 1987, gives EPA the authority to regulate effluents from sewage treatment works, chemical plants, and other industrial sources into waters. The act sets "best available" technology standards for treatment of wastes for both direct and indirect (discharged to a Publicly Owned Treatment Work (POTW)) discharges. EPA originally promulgated effluent limitations guidelines and standards for the plastic resin and manmade fiber industries in two phases. Phase I, covering 13 products and processes, was promulgated on April 5, 1974 (39 FR 12502), and Phase II, covering eight additional products and processes, was promulgated on January 23, 1975 (40 FR 3716). In 1976, these regulations were challenged and eventually remanded by the federal circuit court in FMC Corp. versus Train, 539F, 2d 973 (4th Cir. 1976). As a result, EPA withdrew both the Phase I and II plastic resin and manmade fiber regulations on August 4, 1976 (41 FR 32587) (EPA, 1987).

On November 5, 1987, EPA proposed final effluent guidelines (52FR42522) for the organic chemical, plastics, and synthetic fiber industries (OCPSF) (40 CFR Part 414). The effluent guidelines include limits for biological oxygen demand (BOD), total suspended solids (TSS), and acidity (pH). In this rule, limits are specified for facilities that manufacture rayon fibers, other synthetic fibers, thermoplastic resins, and thermoset resins.

The majority of this rule was upheld by the federal courts in 1989 when the Chemical Manufacturers Association sued the EPA. The Court left the rule in effect pending further rulemaking but remanded three aspects of the OCPSF guidelines. The Court remanded the New Source Performance Standards (NSPS) and the Pretreatment Standards for New Sources (PSNS) for consideration of whether zero discharge limits were appropriate for the industries; the subcategorization of the industries into two subcategories imposing differing limitations based on Best Available Technology Economically Achievable (BAT); and limitations for BAT Subpart J pollutants that were based upon in-plant biological treatment technology.

Pretreatment Standards for New Sources (PSNS)

The EPA decided not to revise the NSPS and PSNS standards or the BAT subcategorization scheme and promulgated two sets of amendments to the rule in 1992 and 1993. On September 11, 1992, EPA promulgated a first set of amendments (57 FR 41836) to the OCPSF rule. These amendments allowed regulatory authorities to establish alternative cyanide limitations and standards for cyanide resulting from complexing of cyanide at the process source and establish alternative metals limitations and standards to accommodate low background levels of metals in non-"metal-bearing waste streams." These amendments also allowed regulatory authorities to specify the method for determining five-day biochemical oxygen demand and total suspended solids effluent limitations for direct discharge plants (FR, September 11, 1992).

Pretreatment Standards for Existing Sources (PSES)

On July 9, 1993, EPA promulgated the remaining portions of the OCPSF rule in a second set of amendments (58 FR 36872) which added Subpart J limitations based on BAT and NSPS for 19 additional pollutants. These amendments also established Pretreatment Standards for Existing Sources (PSES) and PSNS for 11 of these 19 pollutants. EPA also corrected the criteria for designating "metal-" and "cyanide-bearing" waste streams. In this rulemaking, phenol and 2,4-dimethylphenol pretreatment standards were not promulgated since EPA concluded that they did not pass through POTWs. The implementation of the guidelines is left to the states who issue NPDES permits for each facility. The compliance date for PSES was no later than July 23, 1996 (FR, July 9, 1993).

Storm Water Rule

The Storm Water Rule (40 CFR § 122.26(b)(14) Subparts (i, ii)) requires the capture and treatment of stormwater at facilities producing chemicals and allied products, including plastic resin and synthetic fiber manufacture. Required treatment will remove from stormwater flows a large fraction of both conventional pollutants, such as suspended solids and biological oxygen demand (BOD), as well as toxic pollutants, such as certain metals and organic compounds.

600 LEGAL REQUIREMENTS

Resource Conservation & Recovery Act (RCRA)

607.2.3 Resource Conservation and Recovery Act

Products, intermediates, and off-specification products generated at plastic resin and synthetic fiber facilities that are considered hazardous wastes are listed in 40 CFR Part 261.22(f). Some of the handling and treatment requirements for RCRA hazardous waste generators are covered under 40 CFR Part 262 and include the following: determining what constitutes a RCRA hazardous waste (Subpart A); manifesting (Subpart B); packaging, labeling, and accumulation time limits (Subpart C); and record keeping and reporting (Subpart D).

Many plastic resin and synthetic fiber facilities store some hazardous wastes at the facility for more than 90 days, and therefore, are a storage facility under RCRA. Storage facilities are required to have a RCRA treatment, storage, and disposal facility (TSDF) permit (40 CFR Part 2622.34). Some plastic resin and synthetic fiber facilities are considered TSDF facilities and are subject to the following regulations covered under 40 CFR Part 264: contingency plans and emergency procedures (40 CFR Part 264 Subpart D); manifesting, record keeping, and reporting (40 CFR Part 264 Subpart E); use and management of containers (40 CFR Part 264 Subpart I); tank systems (40 CFR Part 264 Subpart J); surface impoundments (40 CFR Part 264 Subpart K); land treatment (40 CFR Part 264 Subpart M); corrective action of hazardous waste releases (40 CFR Part 264 Subpart S); air emissions standards for process vents of processes that process or generate hazardous wastes (40 CFR Part 264 Subpart AA); emissions standards for leaks in hazardous waste handling equipment (40 CFR Part 264 Subpart BB); and emissions standards for containers, tanks, and surface impoundments that contain hazardous wastes (40 CFR Part 264 Subpart CC).

A number of RCRA wastes have been prohibited from land disposal unless treated to meet specific standards under the RCRA Land Disposal Restriction (LDR) program. The wastes covered by the RCRA LDRs are listed in 40 CFR Part 268 Subpart C and include a number of wastes commonly generated at plastic resin and synthetic fiber facilities. Standards for the treatment and storage of restricted wastes are described in Subparts D and E, respectively.

Many plastic resin and synthetic fiber facilities are also subject to the underground storage tank (UST) program (40 CFR Part 280). The UST regulations apply to facilities that store either petroleum products or hazardous substances (except hazardous waste) identified under the Comprehensive Environmental

Response, Compensation, and Liability Act. UST regulations address design standards, leak detection, operating practices, response to releases, financial responsibility for releases, and closure standards.

607.2.4 Toxic Substances Control Act

Toxic Substances Control Act (TSCA)

The Toxic Substances Control Act (TSCA), passed in 1976, gives the Environmental Protection Agency comprehensive authority to regulate any chemical substance whose manufacture, processing, distribution in commerce, use or disposal may present an unreasonable risk of injury to human health or the environment. Four sections are of primary importance to the plastic resin and manmade fiber industries. TSCA § 5 (new chemicals) mandates that plastic resin and manmade fiber companies submit premanufacture notices that provide information on health and environmental effects for each new product and test existing products for these effects (40 CFR Part 720). TSCA § 4 (existing chemicals) authorizes the EPA to require testing of certain substances (40 CFR Part 790). TSCA § 6 gives the EPA authority to prohibit, limit or ban the manufacture, process and use of chemicals (40 CFR Part 750). For certain chemicals, TSCA § 8 also imposes record keeping and reporting requirements, including substantial risk notification; record keeping for data relative to adverse reactions; and periodic updates to the TSCA Chemical Inventory.

Under § 5(h)(4), which grants EPA authority to promulgate rules granting exemptions to some or all of the premanufacture requirements for new chemicals, EPA published an exemption rule in 1984 and an amendment to the rule in 1995. The amendment, entitled Premanufacture Notification Exemptions (PMN) rule, contained a section on polymers (40 CFR Part 723.250) that allowed polymers that met certain restrictions to be exempt from some of the reporting requirements for new chemicals. Two exemptions {40 CFR Part 723.250(e)(1) and (e)(2)} exempt polymers based on molecular weight and oligomer content. The third exemption (40 CFR Part 723.250(e)(3)) exempts certain polyester polymers which use particular monomers and reactants.

In addition to meeting the specific criteria of one of the three exemption types, the new polymer must also not fall into one of the prohibited categories. This section (40 CFR Part 723.250(d)) excludes certain polymers from reduced reporting requirements, namely: certain cationic polymers; polymers that do not meet elemental restrictions; polymers that are reasonably predicted to decompose, degrade, or depolymerize; and polymers which are produced from monomers and/or other reactants which are not on the TSCA inventory or otherwise exempted from reporting under a § 5 exemption.

Pending/ Proposed Regulatory Requirements

607.3 PENDING AND PROPOSED REGULATORY REQUIREMENTS

607.3.1 Clean Air Act

NESHAP for Formaldehyde-based Resin Manufacturers

NESHAP f/ Formaldehyde-based Resin Mfrs.

Presumptive MACT standards were published for amino, phenolic, and acetal resins in July 1996. These resins use formaldehyde as their primary building block. A NESHAP for amino and phenolic resins is expected to be proposed in 1997 and will reduce emissions, primarily, of formaldehyde and methanol. Over 100 facilities are expected to be affected by this rule. EPA is also expecting to propose a NESHAP for acetal resins which will affect three facilities. For more information, please contact John Schaefer at 919-541-0296.

NESHAP f/ Polyether Polyols

NESHAP for Polyether Polyols

A proposed rule for polyether polyols was published in 1997 and the final rule should be signed by May 15, 1999. Roughly 70 major sources in the United States are expected to be affected by this regulation. For more information, please contact David Svendsgaard at 919-541-2380.

NESHAP f/ Polycarbonate Resin Mfrs.

NESHAP for Polycarbonate Resin Manufacturers

This rule was scheduled to be proposed in 1997, and will reduce emissions from polycarbonate resin facilities. It is anticipated that only two major sources in the United States will be affected by this regulation. For more information, please contact Mark Morris at 919-541-5416.

NESHAP f/ Acrylic & Modacrylic Fiber Mfrs.

NESHAP for Acrylic and Modacrylic Fiber Manufacturers

EPA is working on a rule to reduce emissions from acrylic and modacrylic fiber manufacturers. This rule is scheduled to be proposed in 1997 and is expected to primarily reduce emissions of acrylonitrile and vinyl acetate. Only two major sources in the United States will be affected by this regulation. For more information, please contact Leonardo Ceron at 404-562-9129.

701 DETERMINATION OF REASONABLY AVAILABLE CONTROL TECHNOLOGY AND BEST AVAILABLE RETROFIT CONTROL TECHNOLOGY FOR POLYESTER RESIN OPERATIONS

RACT/BARCT

This determination was prepared by the Air Resources Board (ARB) staff in cooperation with the California Air Pollution Control Officers Association's Technical Review Group Solvent Committee.

This chapter presents the determination of Reasonably Available Control Technology (RACT) and Best Available Retrofit Control Technology (BARCT) for polyester resin operations. Also presented in this chapter is the basis for the determination, an overview of the control technology and cost-effectiveness, and associated economic and other impacts.

VOCs

Polyester resin operations include the use of unsaturated polyester resins to fabricate or re-work a variety of products such as spas, tubs, pools, and boat hulls. These processes involve mixing, pouring, hand lay-up, impregnating, injecting, forming or spraying resins with fiberglass, filling, and other activities for the reinforcement of materials. Volatile organic compounds (VOCs) emissions result from these operations during evaporation of monomer when resins are applied and cured and from the use of clean-up solvents. Total statewide VOC emissions from polyester resin operations are estimated to be approximately 25 tons per day. Statewide implementation of the RACT/BARCT standards can reduce between 3 to 5 tons per day of VOCs.

CAPCOA

The determination of RACT and BARCT for polyester resin operations is based on the recommended RACT and BARCT report by the Technical Review Group's (TRG) Solvent Committee of the California Air Pollution Control Officers Association (CAPCOA). The Committee's recommendations are substantially derived from the South Coast Air Quality Management District's rule 1162 and subsequent rules from the San Diego and Ventura County Air Pollution Control Districts. These rules represent the most effective limits and available technology found in California (see Chapter 300, Table 300.7). Upon evaluating the Committee's report, ARB staff proposes that the determination of RACT and BARCT be the same level of control for polyester resin operations.

700 RACT/BARCT

701.1 RACT/BARCT RECOMMENDATION

RACT/ BARCT Determination

ARB staff recommends that the determination (to follow) be defined as RACT/ BARCT for polyester resin operations. As mentioned, RACT and BARCT are the same level of control; therefore the requirements of the proposed determination applies to both. The determination has 3 basic requirements that apply to the process, clean-up and storage, and record keeping. Table 700.1 summarizes the determination of RACT/BARCT. The major requirements of the RACT/ BARCT determination are briefly discussed in the following.

Summary

Table 700.1: Polyester Resin Operations RACT/BARCT Summary

<u>**Standards**</u>

Process and Control Requirements:

* Monomer content ≤ 35 percent by weight.
* Monomer content ≤ 50 percent by weight for specialty resins.
* Vapor suppressed resins with weight loss of ≤ 60 g/m^2.
* Closed-mold system.
* Add-on control devices that achieve a maximum capture efficiency using EPA protocols and achieve a destruction efficiency of at least 85 percent by weight. The overall efficiency of the control system shall be at least as effective in emission reductions as the level of control of complying resins.

Transfer Efficiency:

* Airless, air assisted, high volume low pressure or electrostatic spray equipment.

Cleaning Material Requirements:

* Solvent contains ≤ 1.7 lb. VOC per gallon of solvent;
* Has initial boiling point greater than 190^{0}C; or,
* Use solvent reclamation system.

Table 700.1: (cont.)

Summary

Storage and Disposal Requirements:

* All solvents and wastes to be stored in closed containers and be properly disposed.

Exemptions:

* Touch-up and repair.
* Pigmented gel coats that contain ≤ 45 percent by weight monomer or clear gel coats that contain ≤ 50 percent by weight monomer.

Administrative Requirements:

* Compliance Schedule.
* Record Keeping.

Test Methods:

* Laboratory static test for polyester resin materials.
* EPA method 25A for total hydrocarbons.
* EPA method 8240 for hydrocarbons in liquid.
* ASTM D3960-81 for volatile organics in paints and coatings.
* ASTM D1078-86 for boiling range of volatile organics in liquid.
* ASTM D2369-81 for hydrocarbons content using gas chromatograph.
* ASTM D3792-79 for water content using gas chromatograph.
* ASTM D4457-85 for exempt solvent using gas chromatograph.
* ARB method 401 gravimetric purge and trap for volatile organics.
* EPA guidelines for developing capture efficiency protocols.

Note: ≤ is less than or equal.

701.2 RACT/BARCT DISCUSSION

Process Require-ments f/ RACT/ BARCT

Process requirements include the use of low monomer resins, vapor suppressed resins, or the use of closed-mold systems. These control strategies have lower VOC emissions than conventional resin systems. In addition, high transfer efficiency spray guns such as airless, air assisted airless, or high-volume low pressure spray guns are required for all spraying operations. The spray equipment requirements may be modified in the future based on the study that the ARB will be sponsoring to develop a standard test method to determine transfer efficiency.

As an alternative to the process requirements, a facility may elect to control VOC emissions by the use of add-on control devices that can achieve a combined capture and destruction efficiency as effective as the reduction efficiency of complying resins. Add-on controls must also achieve a maximum collection of fugitive emissions according to the EPA's "Guidelines for Developing Capture Efficiency Protocols" and have a minimum destruction efficiency of at least 85 percent by weight. Note that it is not the intent of this determination to allow the use of bubbling or averaging of emissions to comply with the requirements of this determination. Compliance by bubbling or averaging of emissions are addressed in applicable district rules that apply to alternative emission compliance plans.

The criteria for clean-up and storage requires the use of low VOC solvents for clean-up purposes. However, a person can use clean-up solvents that exceed the standard provided the facility uses a reclamation system to recycle the solvents. For storage requirements, all resins, cleaning solvents, spent solvents, cleaning materials, wastes and unused material containing VOCs shall be stored in closed containers and shall be properly disposed.

The criteria for record keeping requires daily record keeping of resin use, clean-up solvent use, and the content of VOCs in the clean-up solvents. Records shall be retained for 24 months.

The RACT/BARCT determination also provides an exemption for specialty resin applications and specifies test methods for the determination of compliance. The laboratory static test for resin materials is an integral part of the determination to demonstrate compliance.

702 CONTROL TECHNOLOGY

Control Technology

VOC emissions from polyester resin operations can be reduced by using low monomer resins, modifying processes, using vapor suppressed resins, or by add-on emission control devices. The control technologies are briefly highlighted in the following paragraphs. For more detailed explanations, please see Chapter 300.

702.1 LOW MONOMER RESINS

Low Monomer Resins

Low monomer resins that have no more than 35 percent by weight monomer content have been developed and are currently used. However, the use of low monomer resins requires special care during application to ensure that the desired product properties are not degraded. Use of low monomer content resins can achieve approximately 40 percent emission reductions as compared to conventional resins.

702.2 MODIFYING PROCESSES

Modifying Processes

VOC emissions can be reduced by modifying the process to reduce resin use. These modifications include the redesign of products, increase fillers and colorants, elimination of unintentional waste during application, and conversion to closed-mold systems. Depending on a facility's existing method of application and the desired product, utilizing any or a combination of the described process modifications can substantially reduce the emissions from this source.

702.3 VAPOR SUPPRESSED RESINS

Vapor Suppressed Resins

Vapor suppressed resins have been available for several years. To meet the 60 grams per square meter emission limit, manufacturers have typically added small amounts of paraffin wax to the resins. The purpose of this is to provide a surface film that coats the product and reduces the outward diffusion of monomer molecules which results in decreased emissions. However, for multilayer applications, the wax layer may have to be physically removed before applying a new coat to ensure proper bonding.

Emission Control Devices

702.4 EMISSION CONTROL DEVICES

In lieu of using complying resins, polyester resin operators can use add-on emission control devices. Four emission control devices were evaluated as options for use at polyester resin operations: incineration; absorption; adsorption; and condensation. These control technologies have been demonstrated to be highly effective in reducing VOC emissions when exhaust gas concentrations are relatively high. However, exhaust concentrations from polyester resin operations are typically less than 1000 ppm which make these control technologies less effective and not cost-effective.

Impacts

703 IMPACTS

Economic

703.1 ECONOMIC

Most polyester resin operators are expected to comply with the RACT/BARCT standards using complying resins. Vapor suppressed resins are slightly higher in price and require more careful process application than conventional resins. The industry estimates that vapor suppressed resins would cost approximately 2 to 3 cents more per pound than that of conventional resin. The cost impact for facilities that use complying resins is expected to be minimal.

The cost of using control equipment is expected to be much more expensive. The South Coast Air Quality Management District estimates the cost-effectiveness of using control equipment to range from approximately $19,000 per ton ($9.50/lb) of VOC emissions reduced for absorption to $48,000 per ton ($24/lb) for incineration. For small operations, the use of control equipment is expected to be cost prohibitive.

Emission Reductions

703.2 EMISSION REDUCTIONS

Implementation of the RACT/BARCT standards on a statewide basis is expected to result in a reduction of 3 to 5 tons per day of VOC emissions statewide.

703.3 OTHER IMPACTS

Other Impacts

We have identified no adverse environmental impacts associated with the implementation of the RACT/BARCT standards with respect to global warming, plant and animal life, noise levels, land use, or natural resources. The reduction in emissions of VOCs should reduce ozone formation in the state as well as reduce the potential for odors.

703.4 APPLICABILITY

Applicability

Except as provided in "Exemptions," this determination is applicable to commercial and industrial polyester resin operations.

703.5 STANDARDS

Standards

703.5.1 Process and Control Requirements

Process & Control Requirements

1. Any person operating a polyester resin operation shall comply with one or more of the following as applicable:

   (a) Use polyester resin material with a monomer content of no more than 35 percent by weight as applied and as determined by the manufacturer's specification;

   (b) Use specialty resin with a monomer content of no more than 50 percent by weight as applied and as determined by the manufacturer's specification;

   (c) Use a resin containing a vapor suppressant, such that weight loss from VOC emissions does not exceed 60 grams per square meter of exposed surface area during resin polymerization; as determined by methods of analysis (Laboratory Static Test for Polyester Resin Materials for the determination of the resin VOC weight loss);

   (d) Use a closed-mold system; and,

Process & Control Requirements

(e) Install and operate an emissions control system which is designed and operated for the maximum collection of fugitive emissions from polyester resin material, according to the EPA's "Guidelines for Developing Capture Efficiency Protocols," and which system is approved in writing by the Executive Officer, and has a control device with a control efficiency of 85 percent or more on a mass basis as determined by methods of analysis (EPA Method 25A - Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer for the determination of VOC concentration at the exhaust and inlet of the air pollution control device). The overall emission reduction efficiency considering capture and control efficiency shall be equivalent or greater than those emission reduction levels achieved by any requirement specified in (a), (b), or (d) as described above.

Cleaning Materials Requirements

703.5.2 Cleaning Materials Requirements

If cleaning materials contain more than 1.7 pounds of VOC per gallon of material as applied and as determined by EPA Method 8240 (GC/MS Method for Volatile Organics for the determination of VOC in liquid waste), or where the initial boiling point is less than 190 degrees Celsius as determined by ASTM D1078-86 (Determining VOC of Paints and Related Coatings), use a reclamation system when such cleaning materials usage exceeds 4 gallons per day. The reclamation system shall operate with at least 80 percent efficiency. The solvent residues generated from on-site reclamation systems shall not contain more than 20 percent VOC by weight as determined by EPA Method 8240 (Determination of Water Content Using Gas Chromatography).

Storage & Disposal Requirements

703.5.3 STORAGE AND DISPOSAL REQUIREMENTS

1. Use closed containers to store all polyester resin materials, cleaning materials, and any unused VOC-containing materials except when accessed for use;

2. Use self-closing containers for the disposal of all uncured polyester resin materials, cleaning materials, waste materials, and any unused VOC-containing materials in such a manner as to effectively control VOC emissions to the atmosphere; and,

3. Use closed containers to store all scrap materials resulting from cutting and grinding of freshly cured resins.

704 EXEMPTIONS

Exemptions

1. The provisions of Section 705 shall not apply to touch-up and repair.

2. The provisions of Section 705.1, item (a) shall not apply to gel coats provided the monomer content shall not exceed 45 percent by weight for pigmented gel coats and shall not exceed 50 percent by weight for clear gel coats.

705 COMPLIANCE DATES

Compliance Dates

1. A person who is subject to the requirements of this determination shall be in compliance by (within 12 months or from the date of adoption).

2. Facilities operating prior to the effective date and which elect to install and operate an emission control system pursuant to the requirements of subparagraph (e) of Section 703.5.1 shall have a control system installed and operated by (within 12 months from the date of adoption).

706 RECORD KEEPING

Record Keeping

Any person subject to this rule shall comply with the following requirements:

1. A person shall maintain, or have available, a current list of resins and cleaning materials in use which provides all of the data necessary to evaluate compliance, including the following information, as applicable:

   (a) resin, catalyst, and cleaning materials used;

   (b) the weight percent of VOC in each of the polyester resin materials, and the grams of VOC per liter for the cleaning materials; and,

   (c) for approved vapor suppressed resins, the weight loss (grams per square meter) during resin polymerization, the monomer percentage, and the gel time for each resin.

2. A person shall have available records that provide the following information, as applicable:

Record Keeping

(a) the amount of each of the polyester resin materials and cleaning materials used during each day of operation; and,

(b) volume of resin and cleaning materials used for touch-up and repair during each day of operation.

3. Such records shall be retained for the previous 24 month period and be available at the time of inspection.

707 METHODS OF ANALYSIS

Methods of Analysis

The analysis of cleaning materials, polyester resin materials, and control/collection efficiency shall be determined by the appropriate test methods as follows:

1. Laboratory Static Test for Polyester Resin Materials for the determination of the resin VOC weight loss.

2. EPA Method 25A (Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer - for the determination of VOC concentration at the exhaust and inlet of the air pollution control device).

3. EPA Method 8240 (GC/MS Method for Volatile Organics - for the determination of VOC in liquid waste.

4. ASTM D3960-81 (Determining Volatile Organic Content (VOC) of Paints and Related Coatings).

5. ASTM D1078-86 (Distillation Range of Volatile Organic Liquids - for the determination of VOC boiling range of liquid).

6. ASTM D2369-81 (Determination of Volatile Organic Compound Content using Gas Chromatography).

7. ASTM D3792-79 (Determination of Water Content using Gas Chromatography).

8. ASTM D4457-85 (Determination of Exempt Solvents using Gas Chromatography).

9. Air Resources Board Method 401 (Gravimetric Purge and Trap - for the determination of VOC in liquid and solid).

Test Methods

10. EPA Guidelines for Developing Capture Efficiency Protocols.

708 STATIC METHOD FOR DETERMINATION OF VOLATILE EMISSIONS FROM POLYESTER AND VINYL ESTER RESINS

Determination of VOC Emissions from Polyester & Vinyl Resins

708.1 PURPOSE

Purpose

1. This test is designed for the determination of VOC emissions of polyester and vinyl ester resins as received from the manufacturer, according to requirements of California's South Coast Air Quality Management District (SCAQMD) proposed Rule 1162 amendment published July 17, 1990.

2. This test allows fabricators using polyester and vinyl ester resins to monitor VOC emissions (principally styrene monomer) from resins used in the fabrication process. The results are to be reported as VOC losses in grams per square meter (gm/m^2).

708.2 METHOD

Method

The weight of a one gallon can lid filled with 100 gm of resin is accurately measured over a period of time. The measurement is made on resin catalyzed with peroxide initiators to determine weight losses attributed to monomer and other VOC emissions.

708.3 EQUIPMENT REQUIREMENTS

Equipment Requirements

1. Controlled environment at 25^0 C and humidity of 50 percent R.H. If controlled environment is not available, report condition under which measurements are made.

2. Balance with an accuracy of 0.01 gm.

Equipment Requirements

3. Draft free enclosure for balance. This can be achieved by placing the balance in a four sided enclosure that extends a minimum of eight inches above the top of the balance.

4. Gallon can lid with deep form sufficient to contain 100 gm of resin, having a normal diameter of 14.5 cm.

5. Certified or calibrated thermometer capable of measurements accurate to 1^0 C.

6. Constant temperature bath controlled at 25^0 C to adjust resin temperature to 25^0 C.

7. Timer - capable of recording time to 0.1 minute.

8. Paper clip - bent to approximately 90^0 angle.

9. Syringe or pipette accurate to 0.1 ml for peroxide catalyst addition.

Procedures

708.4 PROCEDURE

1. Weigh out 200 gm of prepromoted resin into a suitable dry and clean container. Wax cups should not be used for this test.

2. Cover container and place in constant temperature bath and adjust resin temperature to 25^0 C.

3. Place balance in draft free enclosure.

4. Clean gallon lid with solvent, wipe dry and air dry and measure diameter to the nearest 0.1 cm.

5. Place gallon can lid on an inverted paper or plastic cup mounted on the balance pan. Position bent paper clip in the center of the gallon can lid. Record TARE WEIGHT to $\pm$ 0.01 gm.

6. Take container with resin from water bath and add appropriate volumetric or weight measure of catalyst using syringe or pipette. Start timer.

Procedures

7. Using stirring rod or thermometer, mix in catalyst for one minute.

8. Pour 100.0 $\pm$ 0.5 gm of catalyzed resin into can lid and record weight to $\pm$ 0.01 gm. This is the INITIAL WEIGHT.

9. Using paper clip, determine when resin has hardened sufficiently to allow resin or lid to be lifted.

10. Record this as gel time.

11. Allow resin to harden in can lid and reweigh every 15 minutes until concurrent weighing agrees to within .05 gm. Record this as FINAL WEIGHT to $\pm$ 0.01 gm.

12. Procedure should be repeated until duplicate samples agree to the nearest 5 gm per m^2.

708.5 CALCULATION

Calculations

1. Volatile Organic Compound Emissions Per Square Meter

$$\text{Area of Sample in Square Meter} = \frac{(\text{diameter of lid in cm})^2 \times 3.14}{40{,}000}$$

Volatile Organic Compound Losses Per Square Meter =

$$\frac{\text{Initial Weight - Final Weight}}{\text{Area of Sample in Square Meters}}$$

2. Percent Volatile Organic Compound Emission =

$$\frac{\text{Initial Weight - Final Weight}}{\text{Initial Weight - Tare Weight}} \times 100$$

708.6 REPORTING REQUIREMENTS

Reporting Requirements

1. Ambient temperature and humidity;

2. Resin identification and batch number;

Reporting Requirements

3. Initiator system and amounts used;
4. VOC losses as grams per square meter;
5. Percent VOC emission; and,
6. Gel time under conditions of test.

800 GLOSSARY

AAQS (Ambient Air Quality Standards) are Health and Welfare based standards for clean outdoor air which identify the maximum acceptable average concentrations of air pollutants during a specified period of time.

AB 1807 (Tanner) is a California State law (Health and Safety Code Section 39650 et seq.) which became effective in January of 1984 and established the framework for California's toxic air contaminant identification and control program.

Abrasion is wearing away by friction. Glass is highly resistant to abrasion by other materials, but can be damaged through contact with itself. A lubricant is used during processing and fabrication to prevent abrasion.

Accelerator (Promoter) is a highly active oxidizing agent suspended in a liquid carrier used in conjunction with a catalyst to produce internal heat in a liquid plastic to cure it. Examples are diethylaniline, cobalt naphthanate and cobalt octoate.

Acetone (styrene solubility) is the percentage of the sizing on the glass fiber that is dissolved off the strand in acetone (or styrene) after soaking in the solvent.

Actual End Count is the number of bundles or splits that are actually counted in one doff of roving. This is less than the theoretical end count due to splitting efficiencies of less than 100 percent.

Acute Health Effect is an adverse health effect which occurs over a relatively short period of time (e.g., minutes or hours).

Air Pollutants are the amounts of foreign and/or natural substances occurring in the atmosphere that may result in adverse effects on humans, animals, vegetation, and/or materials.

Air Quality Simulation Model is a mathematical relationship between emissions and air quality which simulates the transport, dispersion, and transformation of compounds emitted into the air.

Air Splice is the coupling between two roving doffs which is made by a jet of air entwining/snarling the two strands together. The air splice is used instead of a knot.

800 GLOSSARY

Air Toxics is a generic term referring to a harmful chemical or group of chemicals in the air. Typically, substances that are especially harmful to health, such as those considered under EPA's hazardous air pollutant program or California's AB 1807 toxic air contaminant program, are considered to be air toxics. Technically, any compound that is in the air and has the potential to produce adverse health effects is an air toxic.

Air Toxics "Hot Spots" Information and Assessment Program (AB 2588) is a California program (Health and Safety Code Section 44300 et seq.) which requires certain stationary sources to report the type and quantity of specific toxic substances they routinely release into the air. The program identifies high priority facilities and requires facilities posing significant risks to notify all exposed individuals.

Ambient Air is the air occurring at a particular time and place outside of structures. Often used interchangeably with outdoor air.

APCD (Air Pollution Control District) is a county agency with authority to regulate stationary, indirect, and area sources of air pollution (e.g., power plants, highway construction, and housing developments) within a given county, and governed by a district air pollution control board composed of the elected county supervisors. (Compare AQMD).

AQMD (Air Quality Management District) is a group of counties or portions of counties, or an individual county specified in law with authority to regulate stationary, indirect, and area sources of air pollution within the region and governed by a regional air pollution control board comprised mostly of elected officials from within the region. (Compare APCD).

ARB (California Air Resources Board) is the State's lead air quality agency consisting of a nine-member Governor-appointed board. It is responsible for attainment and maintenance of the State and federal air quality standards, and is fully responsible for motor vehicle pollution control. It oversees county and regional air pollution management programs.

ASTM is the American Society of Test Methods.

800 GLOSSARY

ATCM (Airborne Toxic Control Measure) is a type of control measure, adopted by the ARB (Health and Safety Code Section 39666 et seq.), which reduces emissions of toxic air contaminants from nonvehicular sources.

Atmosphere refers to the gaseous mass or envelope surrounding the earth.

Attainment Area is a geographic area which is in compliance with the National and/or California Ambient Air Quality Standards (NAAQS or CAAQS).

BACT (Best Available Control Technology) refers to the most up-to-date methods, systems, techniques, and production processes available to achieve the greatest feasible emission reductions for given regulated air pollutants and processes. BACT is a requirement of NSR (New Source Review) and PSD (Prevention of Significant Deterioration).

Ball: see Roving.

Barcol-Shore Rockwell Hardness is a property of material which describes its ability to be indented. The Rockwell method for measuring hardness forces a steel point into the material and then measures the penetration of the point. The different letters in the Rockwell reading describe the shape of the point and the load applied during the test.

BARCT (Best Available Reasonable Control Technology) refers to the most reasonable up-to-date methods, systems, techniques, and production processes available to achieve the greatest feasible emission reductions for given regulated air pollutants and processes. BARCT is a requirement of NSR (New Source Review) and PSD (Prevention of Significant Deterioration).

Bare Glass is glass as it flows from the bushing in fiber form, before a binder or sizing is applied.

Batch House refers to materials being blended together in a bulk quantity, called the "batch." The blended mix is then fed into the furnace or "tank."

Batch Oven is a large temperature-controlled oven, used to heat-clean rolls of glass fiber fabric.

Beam is a spool on which is wound a number of parallel ends of singles or plied yarns, for use in weaving or similar processing operations.

800 GLOSSARY

Beaming is the operation in which many ends of yarn from a creel are combined on a section beam.

Bed is the result of the chopping operation. A mat of chopped glass fibers that is deposited onto a layer of resin mix on a carrier film under the chopper.

Binder is a coating applied to the surface of a chopped glass mat or preform which is then cured. The binder holds the previously sized glass bundles or ends together in the roving operation into a stable shape or form.

Birdnest is a large collection of continuous glass bundles which is tangled up and will not run through the guide eye into roving creel. In the field, a large tangled collection of roving which does not run through the tube or guide eyes to the chopper.

Blade Packings are glass bundles or chopper fuzz which build up and pack between the blades of a chopper. These blade packings can cause poor choppability. If it falls off, it usually does not wet-through, and this can cause blisters or porosity.

BMC is the Bulk Molding Compound (Thermoset).

Bobbin is the spool or shipping package on to which textile yarns are wound.

Braid/Braider is a narrow tubular or flat fabric produced by intertwining a single set of yarns according to a definite pattern.

Break-up: see Dispersion.

Broad Strand: see Wides or Matchsticks.

Broken End is when, in the roving operation, a broken or severed strand (bundle) which causes the forming cake to stop running.

Broken Fibers: see Fuzz.

Build-ups are glass bundles or chopper fuzz which collect on the chopper, cot, static bars or machine frame.

Broken Strand: see Broken End.

Bundles are a discrete collection of many parallel glass filaments. A collection of individual filaments, a sub-strand.

Burn Day is a day officially determined by meteorologists and air pollution specialists to have favorable weather conditions for good dispersal of smoke from the burning of agricultural and wildlands refuse.

Bushing is a plate with holes through which molten glass is pulled to produce glass fibers. The molten glass flows to numerous high heat-resistant platinum trays which have thousands of small, precisely drilled tubular openings, called "bushings."

Bushing Tips are small tapered protrusions on the bottom of bushings each containing an orifice through which molted glass flows, from which continuous filaments are drawn.

Cabled Yarn is yarn that is plied more than once; yarn made by plying two or more previously plied yarns.

Carding is the process of untangling and partially straightening fibers by passing them between two closely spaced surfaces which are moving at different speeds, and at least one of which is covered with sharp points, thus converting a tangled mass of fibers to a filmy web.

Catalyst (Hardener) is a substance which markedly speeds up the cure of a compound by decomposing in the presence of a promoter to release an active oxygen radical. Catalyst content can vary from 0.2% to 2.0% with higher catalyst levels giving faster gel times. Examples are methyl ethyl ketone peroxide, benzoyl peroxide.

Catenary is a consolidated group of individual strands which, when checked between two fixed points of length, exhibit strands of different lengths. The resulting curve between fixed points of the inextensionable material is defined as catenary. The amount of catenary is measured by the distance between the top-most and lower-most strands when stretched between two fixed points.

Cell is the vertical plane of doffs on a pallet. A pallet may be constructed for 4 or 12 end run-out depending on application.

800 GLOSSARY

CFCs (Chlorofluorocarbons) are any of a number of substances consisting of chlorine, fluorine, and carbon. CFCs are used for refrigeration, foam packaging, solvents, and propellants. They are proven to cause depletion of the atmosphere's ozone layer.

Chemical Size is a surface finish applied to the fiber that contains some chemical constituents other than water.

Choppability is the ease of chopping/cutting the glass fibers to a uniform length. Cleaning materials include, but are not limited to, materials for cleaning hands, tools, molds, application equipment, and work area.

Chopped Strand Mat is when, in one operation, the roving is chopped into strands which are combined with a binder to make mat.

Chopped Strands for Compounding is when other strands are chopped and packaged to become CRATEC® Chopped Strands reinforcements for thermoplastic and thermosets.

Chronic Health Effect is an adverse health effect which occurs over a relatively long period of time (e.g., months or years).

Cleaning Materials means materials containing VOCs used for the cleaning of hands, tools, molds and spray equipment associated with polyester resin operations.

Closed Mold System is a method of forming objects from polyester resins by placing the polyester resin material in a confining mold cavity and applying pressure and/or heat.

Clump is a group of chopped bundles of glass fibers which has collected on the SMC machine and then fallen into the bed of glass. The clump produces areas of high glass content which may not wet-through.

Coefficient of Thermal Expansion (CTE) is how much a material shape will change for each degree of temperature change.

Collet is a spool on which the gathered strands from the bushing are wound for further processing.

Composites are compounds, especially any of a class of high-strength, lightweight engineering materials consisting of various combinations of alloys, plastics, and ceramics.

Compounder is a manufacturer who mixes a polymer, fillers, additives and glass fibers, and sells the resulting pellets for injection molding.

Compressive Strength is a number that describes how much of a non-moving load a bar can take before it is crushed. Units are normally thousands of pounds per square inch (10^3 psi) - Mega Pascals (mPa). Higher numbers indicate stronger materials which can withstand a heavier load before they break.

Conformability is the ability of the mat to conform to difficult shapes without causing wrinkles or leaving excessively resin-rich or glass-rich radii, which may craze.

Continuous Filaments are filaments that extend substantially throughout the length of the yarn.

Continuous Filament Mat is when, in a different production step, strands formed below the bushings are treated with a binder and formed into a swirl pattern to make continuous filament mat.

Continuous Heat Resistance is the maximum temperature the material should be subjected to in a continuous application. Below this temperature the material is acceptable. Above this temperature the material may decompose, melt, or otherwise fail in an application. Units - degrees Fahrenheit (^{0}F) - degrees Centigrade (^{0}C). Higher numbers mean that the material can be used continuously at higher temperatures.

Continuous Rovings are rovings supplies in a package that allow for continuous processing.

Control System includes a control device and a collection system.

Controlled Enclosure means a structure having at least three sides and a roof and which is designed to capture process emissions to meet the requirements of all local district prohibitory standards.

800 GLOSSARY

Co-Polymer is a resin produced by copolymerization, the process where unlike molecules are arranged in alternate sequence in a chain.

Coronizing is continuous heat cleaning and weave setting.

Creel used in glass fiber manufacturing is a framework used to hold forming cakes so they can be wound or roved into roving doffs. Creels generally hold 10 to 33 forming cakes which are replaced randomly as they run out as doffs are roved. Creel used in composite fabrication is the area where the pallets of roving are placed and "threaded up" through metal tubes or guide eyes to a chopper. Intermediate packages are rewound from a creel station to form multi-end products for specific performance or composite manufacturing process needs.

Creep is the slow movement of a plastic material with time.

Criteria Air Pollutant is an air pollutant for which acceptable levels of exposure can be determined and for which an ambient air quality standard has been set. Examples include: ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, and PM-10.

Crosslinking is the setting up of chemical links between molecule chains. This occurs in all thermosetting resins. Styrene monomer is a crosslinking agent in polyester resins.

Cure means to polymerize, i.e., to transform from a liquid to a solid or semi-solid state to achieve desired product physical properties, including hardness.

Cure Time is the time required for the liquid resin to reach a cured or fully polymerized state after the catalyst has been added.

Cut Ends on Doff are the severed ends on the doff which generally are caused by abrasion during shipping or by careless use of a knife when the package is removed from the pallet.

DAP is Diallyl Phthalate (Thermoset Resin).

Denier is a direct numbering system for expressing linear density, equal to the mass in grams per 9000m of yarn, filament, fiber, or other textile strand.

800 GLOSSARY

Density is defined as the weight of a material per unit volume. Units - pounds per cubic inch (lb/cu.in) grams/cubic centimeter. Higher numbers indicate heavier materials. Note: Density in lbs/cu in, and Specific Gravity are conveniently related by the following ratio:

$$\frac{\text{Density (lb/cu in)}}{\text{Specific Gravity}} = 0.0361 \qquad \frac{\text{Density (gr/cu cm)}}{\text{Specific Gravity}} = 0.9975$$

Density Fiber is mass per unit volume of the solid matter of which a fiber is composed, measured under specified conditions.

Dielectric Strength is an electrical property and gives an indication of how well the material acts as an electrical insulator. It describes how much of an electrical voltage can be built up on one side of the material before it is communicated to the other side. Units - Volts per mil of thickness (volts/mil). Higher numbers indicate materials which are better insulators. C means that the material conducts electricity and therefore has no dielectric strength.

Direct-Sized Yarn is specially formulated sizings on textile yarns that allow them to be resin compatible.

Dispersion is the degree to which the roving separates into discrete bundles after being chopped. Good dispersion is characterized by a bed of bundles which are uniform in width. Poor dispersion is characterized by a wide distribution in the widths of various bundles in the bed. Poor dispersion can cause poor wet-through and wet-out.

Doff: see Roving Doff.

Doff Collapse is the failure of the roving doff to maintain its shape and stability during run-out or storage. Doff collapse generally occurs when there is only a 1/2" to 1/4" ring of roving left from the original doff.

Dry Loft is the height of the bed of chopped fibers.

E Glass is a family of calcia-alumina-silicate glasses which has a certified chemical composition and which is used for general purposes and most electrical applications.

800 GLOSSARY

Elongation, as mentioned under tensile modulus, when a bar is pulled it gets longer. The elongation tells how much longer it gets before it breaks.

Emission Inventory is an estimate of the amount of pollutants emitted from mobile and stationary sources into the atmosphere over a specific period such as a day or a year.

End is a single bundle of filaments.

Epoxy Resin is the designating of a compound in which an oxygen atom is joined to each of two attached atoms, usually carbon; specifically, designating any of various thermosetting resins, containing epoxy groups, that are blended with other chemicals to form strong, hard, chemically resistant substanced used as adhesives, enamel coatings, etc.

Exothermic Heat is heat given off during a polymerization reaction by the chemical ingredients as they react and the resin cures.

Extruder is a machine that pushes molten plastic through small holes to form fibers.

Fabrication is the portion of the glass fiber production process where the forming cakes are put into creels and "roved" or fabricated onto doffs.

Fall is the shape of the pattern of chopped fibers as they drop from the chopper to the bed.

Fan (or Curtain) are the chopped bundles which fall or are thrown off the chopper and cot.

Fiber is a single glass filament.

Fiber Diameter Letter Designation are fibers generally classified in hundred thousandths, i.e., a "K" fiber has a mean average diameter of 50+ to 55 height.

Letter Designation		Range of Fiber Diameter Up to and Including
A	.00006 in. (1.50 mi.)	.00010 in. (2.50 mi.)
B	.00010 in. (2.515 mi.)	.00015 in. (3.81 mi.)

C	.00015 in. (3.81 mi.)	.00020 in. (5.08 mi.)
D	.00020 in. (5.08 mi.)	.00025 in. (6.35 mi.)
E	.00025 in. (6.35 mi.)	.00030 in. (7.62 mi.)
F	.00030 in. (7.62 mi.)	.00035 in. (8.89 mi.)
G	.00035 in. (8.89 mi.)	.00040 in. (10.12 mi.)
H	.00040 in. (10.12 mi.)	.00045 in. (11.43 mi.)
J	.00045 in. (11.43 mi.)	.00050 in. (12.70 mi.)
K	.00050 in. (12.70 mi.)	.00055 in. 13.97 mi.)
L	.00055 in. (13.91 mi.)	.00060 in. (15.24 mi.)
M	.00060 in. (15.24 mi.)	.00065 in. (16.51 mi.)
N	.00065 in. (16.51 mi.)	.00070 in. (17.78 mi.)
P	.00070 in. (17.78 mi.)	.00075 in. (19.05 mi.)
Q	.00075 in. (19.05 mi.)	.00080 in. (20.32 mi.)
R	.00080 in. (20.32 mi.)	.00085 in. (21.59 mi.)
S	.00085 in. (21.59 mi.)	.00090 in. (22.86 mi.)
T	.00090 in. (22.86 mi.)	.00095 in. (24.13 mi.)
U	.00095 in. (24.13 mi.)	.00100 in. (25.40 mi.)

Note: The letters I and O are not used in this sequence.

Fiberglass primarily means in fiber form. However, "fiberglass" is also used to describe composite processing and applications. Examples of usage are fiberglass molding plant, fiberglass car.

Filament is a single, thread-like fiber of glass. This thin stream of molten glass is pulled and attenuated (drawn down) to a precise diameter, then quenched or cooled by air and water to fix this diameter and create a filament.

Filament Yarn is a yarn composed of continuous filaments assembled with or without twist.

Fill is the system of yarns running crosswise in a fabric (short for filling). Also known as weft (see Warp).

Filler is an inexpensive substance which is added to plastic resins to extend volume, improve properties, and lower cost.

Fines are bundles that have been split apart into smaller bundles which are composed of only a few or single filaments. Fuzz is usually made of fines.

800 GLOSSARY

Finish: see Size.

Fire Retardant Resin means a resin designed for the purpose of delaying the spread of combustion.

Flammability describes how fast a plastic material will burn when subjected to a particular ASTM test. In this test, a flame is applied to one end of a strip of material. When the material starts burning, the flame is removed and the time to consume a given amount of material is measured. Units - inches per minute (in./min.). Higher numbers indicate that the material will burn faster under conditions of this particular test. S.E. means self extinguishing. If a material is classified as S.E., the specimen stops burning when the flame is taken away.

Flexural Strength is also known as bending strength. It describes how much of a non-moving load can be applied before a bar yields or breaks. Units are normally thousands of pounds per square inch. (10^3 psi) - Mega Pascals (mPa). Higher numbers mean that material is stronger and can withstand a heavier load.

Flexural Modulus is a number associated with the stiffness of materials. It is used to calculate how far a bar will bend when a bending load is applied to it. Units are normally millions of pounds per square inch. (10^6 psi) - Giga Pascals (gPa). Higher numbers for materials mean that they are more resistant to deflection when equal thickness is being compared.

Fly means fibers which fly out into the atmosphere during handling and processing.

Forming is the portion of the glass fiber production process where the fibers are drawn, attenuated from molten glass, and collected in forming cakes.

Forming Cakes or "Cakes" is the package of glass fibers which is produced in forming. This package is generally on a tube and is placed on a forming carrier and sent through a drying/curing oven. These "cakes" are subsequently put into a roving creel and collected together into a roving doff.

FRP/C is an abbreviation for fiberglass-reinforced or fiber-reinforced plastic, polymer or polyester composite.

Fugitive Dust are dust particles which are introduced into the air through certain activities such as soil cultivation, off-road vehicles, or any vehicles operating on open fields or dirt roadways.

Furnace refers to such a high temperature that the sand and other ingredients dissolve into molten glass. The inner walls of the furnace are lined with special "refractory" bricks that most periodically be replaced.

Fuzz (Creel Fuzz). In glass fiber manufacturing, the broken filaments found around and on a roving creel. Chopper Fuzz - in Composite Fabrication, the broken filaments found around the glass cutter or chopper (see Fines). In the field, the broken filaments found around a roving pallet.

Fuzz Plugs are small, broken, compacted filaments of glass which collect inside the guide eye tubes which feed the chopper and cause the glass to stop running through it.

Gate is where the molten thermoplastic enters the cavity in the injection molding tool.

Gel is a partial cure of plastic resins; a semi-solid, jelly-like state similar to gelatin in consistency.

Gel Coat is a polyester resin topcoat that provides a cosmetic enhancement and improves resistance to degradation from exposure to the environment.

Gel Time is the time required to change a flowable liquid resin into a non-flowing gel.

GFRP is a glass fiber-reinforced plastic, polymer or polyester.

Glass Blends are when several different fiber types, i.e. different lengths and diameters, are blended in the fiber slurry.

Glass Content is the percentage of glass in the compound.

Glass Fiber Wet-Process is the process of forming a glass mat on modified papermaking equipment.

800 GLOSSARY

Grams of VOC per liter of material is the weight of VOC per volume of material and can be calculated by the following equation:

Grams of VOC per liter of material = $(W_s - W_w - W_{es}) / V_m$

Where:
W_s = weight of VOCs in grams
W_w = weight of water in grams
W_{es} = weight of exempt compounds in grams
V_m = volume of material in liters

GRP is glass-reinforced plastic, polymer or polyester. This derivation is commonly used in Europe.

Hard Glass is a roving product that is not very soluble in acetone or styrene which results in the tendency of the individual bundles to retain their integrity (hardness) and not filamentize in the matrix resin. Hard glass is often stiff and brashy. This size is generally less than 40% soluble in acetone (see Soft Glass).

Hazardous Air Pollutant (HAP) is an air pollutant considered by EPA to be particularly hazardous to health. Emission sources of hazardous air pollutants are identified by EPA, and emission standards are set accordingly.

Heat Cleaning is a batch and continuous processes in which organic yarn binder is removed from glass fabrics.

Heat Distortion Temperature is a measurement of the temperature which will cause the material to bend under a give load. It was developed for thermoplastic materials which soften considerably when heated. It has relatively little value as a design figure for thermosetting reinforced plastics. During this test a load is applied in bending to cause 264 psi stress in the material. The temperature of the material is then raised until the material bends one tenth of an inch at the center. Units - degrees Fahrenheit (^{0}F) - degrees Centigrade (^{0}C). Higher numbers mean that the material can be heated to a higher temperature before it deflects one tenth of an inch under this arbitrary load of 264 psi.

High Volume-low Pressure means spray equipment used to apply coatings by means of a gun which operates between 0.1 and 10.0 psig air pressure, not to exceed 10.0 psig, measured at the air cap of the coating application system, and a permanent liquid coating pressure of not more than 50 psig.

Homopolymer is a compound produced by polymerization.

Hygroscopic is material that absorbs moisture from the air.

Impact Strength-IZOD is the effect of a moving load when it strikes a bar which is denoted by the work "impact." The impact strength of a material is a measure of how much energy is absorbed by the bar when it is broken by a moving weight. There are many different test methods for measuring impact. Izod is but one of these methods. Units - foot pounds per inch of width. (This is sometimes given as foot pounds per inch of notch, Joules/Meter (J/M). Higher numbers mean that the material will absorb more energy before it is broken by a moving weight.

Indoor Air Pollution refers to air pollutants that occur within buildings or other enclosed spaces, as opposed to those occurring in outdoor, or ambient air. Some examples of indoor air pollutants are tobacco smoke, asbestos, formaldehyde, and radon.

Inhibitor is a substance used to slow down or prevent a chemical reaction. Also used to influence gel time and exotherm.

Interface is a surface that lies between two different materials.

Intermediate Package refers to in one type of winding operation, strands are collected into an "immediate" package that is further processed in one of several ways.

Knitted Fabric is a textile structure produced by interlooping one or more ends of yarn or comparable material.

Knot is the means of joining the strands of two doffs of roving. The knot is generally a reduced triple loop surgeon's knot, square knot or overhand knot.

Laminate primarily means a composite material system made with layers of fiber reinforcement in a resin. Sometimes used as a general reference for composites, regardless of how made. Examples of usage are laminate consumption by market, compression-molded laminate.

800 GLOSSARY

Laydown is a characteristic of the bed of chopped glass fibers which relates to the degree of uniformity in thickness that the bed exhibits across the width of the chopped pattern.

Layer is the horizontal plane of doffs on a pallet. A pallet usually has four layers of twelve doffs each.

LOI (Loss on Ignition) is the change in weight of a skein after heating the roving long enough to burn off the organic sizing. LOI includes moisture and solids.

Loom is a mechanical device that interlaces fibers at right angles with varying degrees of weave construction (weight, thickness and design). More modern looms are air jet but rapier and more traditional shuttle equipment is still in use.

Loom Beam is a large, flanged cylinder onto which all warp yarns are wound and from which yarns enter the loom.

Loop is a small open place in the strands due to the excessive length of one or more strands.

Low-VOC emissions resin systems are polyester resin materials which contain vapor suppressants to reduce monomer evaporation loss.

Mat Strength is the ability of the mat to resist being pulled apart under tension during impregnation and molding.

Matchsticks are strand-to-strand adhesion. A matchstick is a wide bundle that has 3 to 4 times as many filaments in it as do the majority of the bundles in the bed.

Matrix is a term used to describe the resin component of a polymer composite. An example of usage would be: "The glass fibers are reinforcing a polyester matrix." The plural is matrices.

Melamine is thermoset resin.

Mobile Sources are sources of air pollution such as automobiles, motorcycles, trucks, off-road vehicles, boats, and airplanes. (Contrast with Stationary Sources).

Moisture is the amount of volatiles on the glass expressed as a percentage of the total weight.

Monitoring is the periodic or continuous sampling and analysis of air pollutants in ambient air or from individual pollutant sources.

Monomer is an organic compound that combines with itself, or other similar compounds by a cross-linking reaction to become a part of a cured thermosetting resin.

Multiple-End Roving Package is for most intermediate packages; the fibers are unwound, then wound again onto a new package with multiple ends of glass. These "conventional" roving doffs are used for such fabrication processes as spray-up and sheet molding compound.

NESHAP is the abbreviation for the National Emission Standards for Hazardous Air Pollutants.

Non-Woven Fabric is a textile structure produced by bonding or interlocking of fibers, or both, accomplished by mechanical, chemical, thermal, or solvent means and combinations thereof.

Orientation is the position with relation to flow of polymer in mold.

Overspray is a specially formulated binder applied to texturized yarn that helps retain the bulk of the yarn after texturizing.

PBT is Polybuthlene Therephthalate (Thermoplastic Polyester Resin).

PET is Polyethylene Terephthalate (Thermoplastic Polyester Resin).

Plastic Resin refers to any of various nonmetallic compounds, synthetically produced, usually from organic compounds by polymerization, which can be molded into various forms and hardened, or formed into pliable sheets or films, fibers, flexible or hard foams, etc. for commerical use.

Plied Yarn is a yarn formed by twisting together two or more single yarns in one operation. (Synonyms: folded yarn, formed yarn.)

800 GLOSSARY

Ply is the number of single yarns twisted together to form a plied yarn; also the number of plied yarns twisted together to form a cord. The individual yarn in a plied yarn or in a cord. One of several layers of fabric.

Poisson's Ratio is the ratio of transverse strain to axial strain during axial load.

Pollution Prevention is the use of materials, processes, or practices to reduce, minimize, or eliminate the creation of pollutants or wastes. It includes practices that reduce the use of toxic or hazardous materials, energy, water, and/or other resources.

Polyester is a complex polymeric ester containing difunctional acids and alcohols which is dissolved in a monomer.

Polyester Combination Yarn is a polyester/fiberglass hybrid yarn.

Polyester Resin Materials include, but are not limited to, unsaturated polyester resins such as isophthalic, orthophthalic, halogenated, bisphenol-A, vinyl-ester, or furan resins; cross-linking agents; catalysts, gel coats, inhibitors, accelerators, promoters, and any other VOC containing materials in polyester resin operations.

Polyester Resin Operations are methods used for the production or rework of products by mixing, pouring, hand lay-up, impregnating, injecting, forming, winding, spraying, and/or curing unsaturated polyester resin materials with fiberglass, fillers, or any other reinforcement materials and associated cleanup.

Polymer is a chemical compound comprised of a large number of chemical units composed of identical cross-linked groups, and which is formed by the chemical linking of monomers, such as polystyrene.

Polyurethanes are any of various synthetic polymers produced by the polymerization of a hydroxyl (OH) radical and an NCO group from two different compounds, typically used in elastic fibers, cushions, insulation, molded products, coatings, etc.

Polyvinyl Chloride (PVC) is any of a family of polymers derived from vinyl chloride; they have many uses in various forms, as in rigid plastic pipes and clear, filmy food wrappers.

Post Bake: see Post Cure.

Post Cure is a heat cycle a roving doff goes through after fabrication. This is generally used to help "set" the ribbon on the outside of the doff to improve the doff's stability and resistance to package.

PPO is Polyphenylene Oxide (Thermoplastic Resin).

PPS is Polyphenylene Sulfide (Thermoplastic Resin).

PRF is Polyester Resin Facility.

Raw Materials usually contain more than half silica sand, the basic building block of any glass. Other ingredients are borates and trace amounts of specialty chemicals.

Re-Chop are bundles which have clung to the chopper or cot which are chopped again into shorter lengths. Re-chop causes excessive chopper fuzz as the strands are cut and mashed into smaller bundles.

Reclamation System means equipment capable of reclaiming spent cleaning materials for reuse. Reclamation may be done onsite or by using an offsite commercial reclamation facility.

Repair is that part of the fabrication process that requires the addition of polyester resin material to portions of a previously fabricated product in order to mend minor structural damage.

Resin is any of a class of organic polymers of natural or synthetic origin used in reinforced products to surround and hold fibers, and is solid or semi-solid in the cured state.

Ribbon is the propensity of the glass bundles to "stick" together and act as a strand or end.

Risk Assessment is an evaluation of risk which estimates the relationship between exposure to a harmful substance and the likelihood that harm will result from that exposure. Risk assessments are generally expressed as the estimated chance per million that a person, exposed over some period of time (e.g., a 70 year lifetime) and some specified concentration of exposure, will experience a certain effect.

Risk Management is an evaluation of the need for and feasibility of reducing risk. It includes consideration of magnitude of risk, available control technologies, and economic feasibility.

Roving Doff or "Doff" is the final product sold to the customer. It was made by roving or pulling together a group of forming cakes (the number of which depends upon the product being made).

Roving is a collection of untwisted strands would together into a doff (ball). Also, another name for the fabrication process step.

RP is reinforced plastic, polymer or polyester.

RTP is sometimes used to distinguish reinforced thermoplastic from reinforced thermosetting plastic.

Rule-of-Mixtures is when combined, the properties of the composite material is some combination of the properties of the two constituent materials. The composite property equals the amount of the fiber property multiplied by the volume percentage of fiber, plus the amount of matrix property multiplied by the volume percentage of matrix.

Run-Out is the process of pulling the glass from the doff to the chopper.

Runner is the channel through which thermoplastic material moves through a mold.

SAN is Styrene Acrylonitrile (Thermoplastic Resin).

S Glass is a family of magnesium-alumina-silicate glasses with a certified chemical composition which conforms to an applicable material specification and which produces high mechanical strength.

S-2 Glass® Fiber is the Owens Corning trademarked brand of high tensile strength "S" glass fibers.

Scrim is a light, woven or non-woven fabric with relatively large openings between the yarns, used as reinforcement for paper and other products.

Secton Beam is a flanged cylinder onto which yarn is drawn and accumulated from yarn bobbins or packages.

Serving is the wrapping of yarn around a product in one or more layers, to form a protective covering.

Sewing Thread is a flexible, small diameter yarn or strand, usually treated with a surface coating, lubricant, or both, intended to be used to stitch one or more pieces of material or an object to a material.

SIC refers to the codes from their Standard Industrial Classification.

Single Yarn is the simplest strand of textile material suitable for operations such as weaving, knitting, etc.

Size is the treatment applied to the glass fiber to allow the resin and glass to adhere to one another. Also allows glass fiber to be conveniently handled. The hair-like filaments are coated with an aqueous chemical mixture called a "sizing," which serves two main purposes: 1) protecting the filaments from each other during processing and handling, and 2) ensuring good adhesion of the glass fiber to the resin.

Skein is a loose coil of roving or strands which is generally used as a Quality Control sample.

Slashing is the method of applying size to a width of warp yarns on a continuous basis.

Slinks are glass bundles which are thrown off the chopper or cut during the chopping operation.

Sliver is a term used to describe the geometry of a fibrous glass reinforcement in the forming operation, e.g., 2K37 S/2 meaning a configuration in forming which makes a nominal fiber diameter in the "K" range which is 3,700 yards to a pound and is split into two discrete bundles in the forming cake.

Sluffing: see Doff Collapse.

800 GLOSSARY

Smog is a combination of smoke, ozone, hydrocarbons, nitrogen oxides, and other chemically reactive compounds which, under certain conditions of weather and sunlight, may result in a murky brown haze that causes adverse health effects. The primary source of smog in California is motor vehicles.

Smoke is a form of air pollution consisting primarily of particulate matter (i.e., particles). Other components of smoke include gaseous air pollutants such as hydrocarbons, oxides of nitrogen, and carbon monoxide. Sources of smoke may include fossil fuel combustion, agricultural burning, and other combustion processes.

Snarl: see Birdnest.

Soft Glass is a roving product whose sizing is moderately soluble in acetone or styrene which results in the tendency of the bundles to open readily or filamentize the matrix resin. The size is generally between 50% and 80% soluble in acetone.

Solid is the amount of sizing on the glass expressed as a percentage of the total weight.

Specialty Resin is any halogenated, furan, bisphenol A, vinyl ester, or isophthalic resin used to make products for exposure to one or more of the following extreme environmental conditions: acute or chronic exposure to corrosive, caustic, acidic, agents, or flame.

Specific Gravity describes the weight of a material in relation to the weight of an equal volume of water. For example, a material with a Specific Gravity of 2.0 weighs twice as much as an equal volume of water. Units - Because specific gravity is a ratio of values for two materials, there are no units. Higher numbers indicate heavier materials.

Specific Heat (Thermal Capacity) defines how much heat is needed to raise the temperature of one pound of material one degree Fahrenheit. Units - BTUs per pound per degree Fahrenheit (BTA/lb/^{0}F) - Joules/Kilogram Kelvin (J/KgK). Higher numbers means that it takes more input heat energy to raise the temperature of a material.

Splicing is the joining of two ends of yarn by intertwining, knotting, overlapping or adhering them together.

Split is one bundle.

Sprue is the connector between the runner and the nozzle in the injection molding machine.

Splitting Efficiency is the ratio of the actual number of ends divided up by the theoretical number of ends in a roving doff. Expressed as a percentage.

Staples are the filaments produced in short lengths from the bushing (usually less than 17 inches), to be gathered into strands or sliver. (See Continuous Filament).

Static is the build-up of an electrical charge which causes the chopper roving to "cling" or stick to the chopper, line and/or people. The static level is quantified by measuring the electrical field strength in kilovolts per inch.

Stationary Sources are non-mobile sources such as power plants, refineries, and manufacturing facilities which emit air pollutants. (Contrast with Mobile Sources).

Sticker: see Trapped End.

Strand is a primary group of bundles gathered together in a creel in the roving process or shop. A strand is that which is pulled out of a doff. A plurality of drawn and elongated individual filaments combined together to form an individual strand. Strands are held together and protected by the sizing. After the sizing is applied, filaments are gathered together into twine-like strands that go through one of three steps, depending on the type of reinforcement being made.

Strand Count is the U.S. Yardage System is the length, in hundreds of yards, of a single strand having a mass of one pound. European TEX System: the mass, in grams, of a strand 1,000 meters in length.

Strand Integrity is relating to the ability of the size to keep all the filaments of a bundle stuck together during chopping. Good strand integrity is required for good flow in or wet-through and wet-out on the mold.

Styrene Monomer is a water-thin liquid monomer used to thin polyester resins and act as the crosslinking agent.

Synthetic (or Manmade) Resins are any of a large class of complex organic liquids or solids formed from simpler molecules by condensation or polymerization, used especially in making plastics, and/or any of various chemically modified natural resins.

Tape is a narrow fabric with a mass per unit area of less than 0.5 kg/m^2 (0.1 lb/ft^2) for each 25.4 mm (1 in.) of width and which is used primarily for utilitarian purposes.

Tensile Modulus is used to calculate how much longer a bar will get when a certain load is applied to it. Units are normally millions of pounds per square inch. (10^6 psi) - Giga Pascals (gPa). Higher numbers indicate materials which will not elongate as much as others when they are being compared under equal tensile loading conditions.

Tensile Strength is a number that describes how large a non-moving load a bar can withstand before it breaks due to elongation. Units are normally thousands of pounds per square inch. (10^3 psi) - Mega Pascals (mPa). Higher numbers indicate materials which can withstand a stronger pull before breaking.

Tension Device is a mechanical or magnetic device that controls tension.
TEX is a unit for expressing linear density, equal to the mass in grams of 1 km of yarn, filament, fiber or other textile strand.

Texturized Glass Yarn is a yarn processed from continuous filament yarn in such a manner to induce bulk to the yarn by disorientation of the filaments.

Thermal Coefficient of Expansion is a measurement of how much the length of a material will change when the material is heated or cooled. The value given is based on the inch as a unit. The number given shows how much this inch of material will increase if the temperature of the material is raised one degree Fahrenheit. Units - inches per inch per degree Fahrenheit (in/in/^{0}F) - Meters/Meter/^{0}C. Higher numbers mean that the material will expand or lengthen more for each degree rise in temperature. Smaller number indicate relative stability to changes in temperature.

Thermal Conductivity is a property known as the K factor. It is a measure of the transfer of heat by conduction. It tells how much heat is transferred from one side of a plate to the other side. It is measured as BTUs (units of heat in the

English system) per hour per unit area (square feet) for a thickness of one inch and a temperature difference of one degree Fahrenheit between both sides of the plate. Units - BTU/hr/sq/^{0}F/inch. - Watt/(Meter Deg Kelven) W/MK. Higher numbers mean that the material will absorb more energy before it is broken by a moving weight.

Thermoset is a material that will undergo a chemical reaction caused by heat, catalyst, etc., leading to the formation of a solid. Once it becomes a solid, it cannot be reformed.

Theoretical End Count is the maximum number of bundles that are in a roving doff, e.g., a roving doff made with 18 forming cakes in the creel that were "split out" 4 ways in forming will have 64 theoretical ends.

Thickeners are materials added to the resins to thicken or raise the viscosity index of the resin so that it will not flow as readily.

Thixotropic is the property of becoming a gel at rest, but liquefying again on agitation.

Touch-up is that portion of the fabrication process that is necessary to cover minor imperfections.

Transfer is the smooth and successful transition from one roving doff to another during processing.

Trapped End is a loop which was embedded into the roving doff during the roving process which gets stuck during run-out with sufficient tenacity that it prevents the entire strand from running freely to the chopper.

Tube Stoppage or Plug is the failure of the glass to run through the metal tubes or guide-eyes from the creel to the chopper. This is usually caused by a large knot or small birdnest becoming stuck inside the tube or guide-eye.

Turn is one 360^0 revolution of the components around the axis of the strand.

Turnaround is the portion of the roving doff where the roving changes direction when it is pulled out of the doff.

Twist and Ply Frames are machines used to twist the ply glass yarns.

800 GLOSSARY

Type 30® Roving Package is used for collecting strands into a single-end roving package. Most of these packages are shipped directly to customers for such processes as pultrusion and filament winding.

Untied Ends is the lack of a knot or splice between two doffs, one on top of the other, which prevents successful transfer from the top doff to the bottom doff in a creel par.

Untreated is a descriptive term for glass fiber yarns having no applied chemicals or coatings, other than the minimal lubricant or binder used to control intra-fiber abrasion.

Vapor Suppressant is a substance added to resin to minimize the outward diffusion of monomer vapor into the atmosphere.

Vapor Suppressed Resin means a resin which has been modified to minimize the weight loss from VOC emissions during polymerization.

Vinyl-Coated Glass Yarn is a continuous glass filament yarn, coated with a pigment and plasticized vinyl chloride resin.

Viscosity is a measure of the resistance of a liquid to flow.

Visibility is the distance that atmospheric conditions allow a person to see at a given time and location. Visibility reduction from air pollution is often due to the presence of sulfur and nitrogen oxides, as well as particulate matter.

Volatile Organic Compound (VOC) is any volatile compound of carbon, excluding methane, carbon monoxide, carbon dioxide, caronic acid, metallic carbides or carbonates, ammonium carbonate, 1,1,1 trichloroethane, methylene chloride, trifluoromethane (HFC-23), trichlorofloumethane (CFC-11), dichlorodifluoromethane (CFC-12), trichlorotrifluoroethane (CFC-113), chlorodifluoromethane (HCFC-22), dichlorotetrafluoroethane (CFC-114), chloropentafluoroethane (CFC-115), dichlorotrifluoroethane (HCFC-123), tetrafluoroethane (HFC-134a), dichlorofluoroethane (HCFC-141b), and chlorodifluoroethane (HCFC-142b) which exist in the ambient air. VOCs contribute to the formation of smog and/or may themselves be toxic. VOCs often have an odor, and some examples include gasoline, alcohol, and the solvents used in paints.

Warp is the yarn running lengthwise in a woven fabric. A group of yarns in long lengths and approximately parallel, put on beams on warp reels for further textile processing including weaving, knitting, twisting, dyeing, etc.

Warp Size are chemicals applied to the warp yarn to improve strand integrity, strength and smoothness in order to withstand rigors of weaving.

Waste Material means any waste material containing VOC including, but not limited to, any paper or cloth used for cleaning operations, waste resins, and any spent cleaning materials containing VOC.

Weft is the system of yarns running crosswise in a fabric. Also known as fill.

Wet-Out is the degree and/or rate at which each individual filament is "wet" or encapsulated by the matrix polymer resin in a composite sheet. Relates to the ability of the polymer matrix resin system to move through the glass fiber bed and to attain complete encapsulation of each individual filament. A measure of the wetability of the sized glass fiber surface.

Wet-Process is a process for forming a non-woven web from a water slurry on "papermaking" equipment. Also known as "wet-laid" or "wet-formed."

Wet-Through is the degree and/or rate of encapsulation of the sized glass fiber bundles in a laminate. The rate and/or degree of which the polymer matrix resin system can flow through the bed of sized glass bundles or strands and encapsulate each bundle of filaments.

Wides is a term used to describe bundles of roving which are wider than most of the other bundles in the bed of chopped glass fibers. These usually contain 3 to 4 times as many filaments per bundle as do most of the other bundles in the roving. (See Matchstick).

Winders are used to wind strand onto which collect the continuous fiberglass into balls or "doffs."

Yardage is similar to Yield (see) but used to describe the linear density of "bare glass" or an unsized product. Yardage specifies the number of yards of glass required to weigh one pound. It is measured in hundreds. For example, K18 is a K fiber that has 1,800 yards in one pound of glass.

800 GLOSSARY

Yarn is a generic term for a continuous strand of textile fibers, filaments, or material in a form suitable for knitting, weaving, or otherwise intertwining to form a textile fabric.

Yield refers to the linear density of a roving or yarn and is measured as the number of yards per pound.

APPENDIX A

I. SUBSTANCES IDENTIFIED AS TOXIC AIR CONTAMINANTS BY THE AIR RESOURCES BOARD, PURSUANT TO THE PROVISIONS OF AB 1807 AND AB 2728 (INCLUDES ALL HAZARDOUS AIR POLLUTANTS LISTED IN THE FEDERAL CLEAN AIR ACT AMENDMENTS OF 1990).

II. POLYCYCLIC ORGANIC MATTER.

APPENDIX A

Toxic Air Contaminant Identification List
August 1998

I. Substances identified as Toxic Air Contaminants by the Air Resources Board, pursuant to the provisions of AB 1807** and AB 2728** (includes all Hazardous Air Pollutants listed in the Federal Clean Air Act Amendments of 1990).

Acetaldehyde
Acetamide
Acetonitrile
Acetophenone
2-Acetylaminofluorene
Acrolein
Acrylamide
Acrylic acid
Acrylonitrile
Allyl chloride
4-Aminobiphenyl
Aniline
o-Anisidine
*Asbestos
*Benzene (including benzene from gasoline)
Benzidine
Benzotrichloride
Benzyl chloride
Biphenyl
Bis(2-ethylhexyl)phthalate {DEHP}
Bis(chloromethyl)ether
Bromoform
*1,3-Butadiene
Calcium cyanamide
Caprolactam *(EPA delisted HAP 6-18-96)*
Captan
Carbaryl
Carbon disulfide
*Carbon tetrachloride {Tetrachloromethane}
Carbonyl sulfide
Catechol
Chloramben
Chlordane
Chlorine
Chloroacetic acid
2-Chloroacetophenone
Chlorobenzene
Chlorobenzilate
*Chloroform
Chloromethyl methyl ether
Chloroprene
Cresols/Cresylic acid (isomers and mixtures)
o-Cresol
m-Cresol
p-Cresol
Cumene
2,4-D, salts and esters
DDE {*p,p*-Dichlorodiphenyldichlorethylene}
Diazomethane
Dibenzofurans
1,2-Dibromo-3-chloropropane {DBCP}
Dibutylphthalate
1,4-Dichlorobenzene {*p*-Dichlorobenzene}
3,3-Dichlorobenzidene
Dichloroethyl ether {Bis(2-chloroethyl)ether}
1,3-Dichloropropene
Dichlorvos {DDVP}
Diethanolamine
N,N-Diethyl aniline {N,N-Dimethylaniline}
Diethyl sulfate
3,3-Dimethoxybenzidene
4-Dimethyl aminoazobenzene
3,3-Dimethyl benzidene
Dimethyl carbamoyl chloride
Dimethyl formamide
1,1-Dimethyl hydrazine
Dimethyl phthalate
Dimethyl sulfate
4,6-Dinitro-o-cresol, and salts
2,4-Dinitrophenol
2,4-Dinitrotoluene
1,4-Dioxane {1,4-Diethyleneoxide}
1,2-Diphenylhydrazine
Epichlorohydrin {1-chloro-2,3-epoxypropane}
1,2-Epoxybutane
Ethyl acrylate
Ethyl benzene
Ethyl carbamate {Urethane}
Ethyl chloride {Chloroethane}
*Ethylene dibromide {1,2-Dicbromoethane}

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*Ethylene dichloride {1,2-Dichloroethane}
Ethylene glycol
Ethylene imine {Aziridine}
*Ethylene oxide {1,2-Epoxyethane}
Ethylene thiourea
Ethylidene dichloride {1,1-Dichloroethane}
*Formaldehyde
Heptachlor
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Hexamethylene-1,6-diisocyanate
Hexamethylphosphoramide
Hexane
Hydrazine
Hydrochloric acid
Hydrogen fluoride {Hydrofluoric acid}
Hydroquinone
Isophorone
Lindane (all isomers)
Maleic anhydride
Methanol
Methoxychlor
Methyl bromide {Bromomethane}
Methyl chloride {Chloromethane}
Methyl chloroform {1,1,1-Trichloroethane}
Methyl ethyl ketone {2-Butanone}
Methyl hydrazine
Methyl iodide {Iodomethane}
Methyl isobutyl ketone {Hexone}
Methyl isocyanate
Methyl methacrylate
Methyl tert butyl ether {MTBE}
4,4-Methylene bis(2-chloroaniline)
*Methylene chloride {Dichloromethane}
Methylene diphenyl diisocyanate {MDI}
4,4-Methylenedianiline
Naphthalene
Nitrobenzene
4-Nitrobiphenyl
4-Nitrophenol
2-Nitropropane
N-Nitroso-N-methylurea
N-Nitrosodimethylamine
N-Nitrosomorpholine
Parathion
***Particulate emissions from diesel-fueled engines** *(added by ARB in 1998)*
Pentachloronitrobenzene {Quintobenzene}
Pentachlorophenol
*Perchloroethylene {Tetrachloroethylene}
Phenol
p-Phenylenediamine
Phosgene
Phosphine
Phosphorus
Phthalic anhydride
Polychlorinated biphenyls {PCBs, Aroclors}
1,3-Propane sultone
beta-Propiolactone
Propionaldehyde
Propoxur {Baygon}
Propylene dichloride {1,2-Dichloropropane}
Propylene oxide
1,2-Propylenimine {2-Methyl aziridine}
Quinoline
Quinone
Styrene
Styrene oxide
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin {TCDD}
1,1,2,2-Tetrachloroethane
Titanium tetrachloride
Toluene
2,4-Toluene diamine {2,4-Diaminotoluene}
2,4-Toluene diisocyanate
o-Toluidine
Toxaphene {Chlorinated camphene}
1,2,4-Trichlorobenzene
1,1,2-Trichloroethane
*Trichloroethylene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
Triethylamine
Trifluralin
2,2,4-Trimethylpentane
Vinyl acetate
Vinyl bromide
*Vinyl chloride
Vinylidene chloride {1,1-Dichloroethylene}
Xylenes (isomers and mixture)
m-Xylenes
o-Xylenes
p-Xylenes

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+ Antimony Compounds
+*Arsenic Compounds (inorganic including arsine)
+ Beryllium Compounds
+ Cadmium Compounds
  ****Cadmium (metallic cadmium and cadmium compounds)***
+ Chromium Compounds
  ***Chromium VI**
+ Cobalt Compounds
+ Coke Oven Emissions
+ Cyanide Compounds[1]
+ Glycol Ethers[2]
+ Lead Compounds
  ***Inorganic lead and inorganic lead compounds (includes elemental lead)** *(added by ARB in 1997)*
+ Manganese Compounds
+ Mercury Compounds
+ Fine Mineral Fibers[3]
+*Nickel Compounds
+ Polycyclic Organic Matter[4] (includes **Chlorinated dioxins**)
+ Radionuclides (including radon)[5]
+ Selenium Compounds

* = *Substances which have already been identified by the Board as TACs and which have potency numbers developed by the OEHHA and SRP.*

** = *AB 1807, Statutes 1983, chapter 1047, Health & Safety Code section 39650 et. seq. AB 2728, Statutes 1992, chapter 1161, Health & Safety Code sections 39655 et. seq.*

\+ = *For all listings above which contain the word "compounds" and for glycol ethers, the following applies: Unless otherwise specified, these listings are defined as including any unique chemical substance that contains the named chemical (i.e., antimony, arsenic, etc.) as part of that chemical's infrastructure.*

1 *Cyanide compounds: X'CN where X=H' or any other group where a formal dissociation may occur. For example: KCN or Ca(CN)2*

2 *Glycol ethers: Includes mono- and di-ethers of ethylene glycol, diethylene glycol, and triethylene glycol ($R(OCH_2CH_2)_n$-OR' where*
n = 1,2 or 3
R = alkyl or aryl groups
R' = R,H, or groups which, when removed, yield glycol ethers with the structure; $R(OCH_2CH)_n$-OH. Polymers are excluded from the glycol category.

3 *Fine mineral fibers: Includes mineral fiber emissions from facilities manufacturing or processing glass, rock, or slag fibers (or other mineral derived fibers) of average diameter 1 micrometer or less.*

4 *Polycyclic organic matter: Includes organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100° C.*

5 *Radionuclides: A type of atom which spontaneously undergoes radioactive decay*

On April 8, 1993, the Board identified all federal hazardous air pollutants (HAPs) as toxic air contaminants (TACs). ***TAC's that are not specifically listed as HAPs are in bold.***

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II. The Air Resources Board Title V web site defines ***"polycyclic organic matter"*** as "Limited to, or refers to, products from incomplete combustion of organic compounds (or material) and pyrolysis processes having more than one benzene ring, and which have a boiling point greater than or equal to 100° C." These compounds include, but are not limited to:

CAS	Chemical Name
35822469	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin
67562394	1,2,3,4,6,7,8-Heptachlorodibenzofuran
55673897	1,2,3,4,7,8,9-Heptachlorodibenzofuran
39227286	1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin
70648269	1,2,3,4,7,8-Hexachlorodibenzofuran
57653857	1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin
57117449	1,2,3,6,7,8-Hexachlorodibenzofuran
19408743	1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin
72918219	1,2,3,7,8,9-Hexachlorodibenzofuran
40321764	1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin
57117416	1,2,3,7,8-Pentachlorodibenzofuran
122667	1,2-Diphenylhydrazine {Hydrazobenzene}
42397648	1,6-Dinitropyrene
42397659	1,8-Dinitropyrene
82280	1-Amino-2-methylanthraquinone [PAH- Derivative]
134327	1-Naphthylamine
5522430	1-Nitropyrene
60851345	2,3,4,6,7,8 Hexachlorodibenzofuran
57117314	2,3,4,7,8-Pentachlorodibenzofuran
1746016	2,3,7,8-Tetrachlorodibenzo-p-dioxin {TCDD}
51207319	2,3,7,8-Tetrachlorodibenzofuran
53963	2-Acetylaminofluorene
117793	2-Aminoanthraquinone
129157	2-Methyl-1-nitroanthraquinone (uncertain purity)
91598	2-Naphthylamine
607578	2-Nitrofluorene
90437	2-Phenylphenol
28434868	3,3'-Dichloro-4,4'-diaminodiphenyl ether
91941	3,3'-Dichlorobenzidine
119904	3,3'-Dimethoxybenzidine
20325400	3,3'-Dimethoxybenzidine dihydrochloride
119937	3,3'-Dimethylbenzidine {*o*-Tolidine}
6109973	3-Amino-9-ethylcarbazole hydrochloride
56495	3-Methylcholanthrene
101804	4,4'-Diaminodiphenyl ether
80057	4,4'-Isopropylidenediphenol
101611	4,4'-Methylene bis (N,N-dimethyl benzenamine
101144	4,4'-Methylene bis(2-chloroaniline) {MOCA}
838880	4,4'-Methylene bis(2-methylaniline)
101779	4,4'-Methylenedianiline (and its dichloride)
139651	4,4'-Thiodianiline
92671	4-Aminobiphenyl
60117	4-Dimethylaminoazobenzene
92933	4-Nitrobiphenyl
57835924	4-Nitropyrene
3697243	5-Methylchrysene
602879	5-Nitroacenaphthene
7496028	6-Nitrochrysene
57976	7,12-Dimethylbenz[a]anthracene
83329	Acenaphthene
208968	Acenaphthylene
62476599	Acifluorfen
23214928	Adriamycin
28981977	Alprazolam
120127	Anthracene
492808	Auramine
103333	Azobenzene
56553	Benz[a]anthracene
92875	Benzidine (and its salts)
1020	Benzidine-based dyes
50328	Benzo[a]pyrene
205992	Benzo[b]fluoranthene
191242	Benzo[g,h,i]perylene
205823	Benzo[j]fluoranthene
207089	Benzo[k]fluoranthene
5411223	Benzphetamine hydrochloride
1694093	Benzyl violet 4B
92524	Biphenyl
4680788	C. I. Acid Green 3
569642	C. I. Basic Green 4
989388	C. I. Basic Red 1
569619	C. I. Basic Red 9 monohydrochloride

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CAS	Chemical Name
2832408	C. I. Disperse Yellow 3
63252	Carbaryl
1620219	Chlorcyclizine hydrochloride
510156	Chlorobenzilate {Ethyl-4,4'-dichlorobenzilate}
218019	Chrysene
87296	Cinnamyl anthranilate
6358538	Citrus Red No. 2
50419	Clomiphene citrate
3468631	D and C Orange No. 17
81889	D and C Red No. 19
2092560	D and C Red No. 8
5160021	D and C Red No. 9
20830813	Daunomycin
23541506	Daunorubicin hydrochloride
50293	DDT {1,1,1-Trichloro-2,2-bis(*p*-chlorophenyl)ethane}
1163195	Decabromodiphenyl oxide
226368	Dibenz[a,h]acridine
53703	Dibenz[a,h]anthracene
224420	Dibenz[a,j]acridine
192654	Dibenzo[a,e]pyrene
189640	Dibenzo[a,h]pyrene
189559	Dibenzo[a,i]pyrene
191300	Dibenzo[a,l]pyrene
132649	Dibenzofuran
	Dibenzofurans (chlorinated) (see Polychlorinated dibenzofurans)
	Dibenzofurans (Polychlorinated dibenzofurans) {PCDFs}
72548	Dichlorodiphenyldichloroethane {DDD}
72559	Dichlorodiphenyldichloroethylene {DDE}
115322	Dicofol
84173	Dienestrol
56531	Diethylstilbestrol
630933	Diphenylhydantoin
1937377	Direct Black 38
2602462	Direct Blue 6
16071866	Direct Brown 95 (technical grade)
2475458	Disperse Blue 1
379793	Ergotamine tartrate
33419420	Etoposide
206440	Fluoranthene
86737	Fluorene
23092173	Halazepam
1335871	Hexachloronaphthalene
193395	Indeno[1,2,3-cd]pyrene
77501634	Lactofen
846491	Lorazepam
72435	Methoxychlor
101688	Methylene diphenyl diisocyanate {MDI}
90948	Michler's ketone
59467968	Midazolam hydrochloride {Chlornaphazine}
86306	Nitrosodiphenylamine
86220420	Nafarelin acetate
3771195	Nafenopin
91203	Naphthalene
97563	*o*-Aminoazotoluene
303479	Ochratoxin A
2234131	Octachloronaphthalene
2646175	Oil Orange SS
60093	*p*-Aminoazobenzene {4-Aminoazobenzene}
156105	*p*-Nitrosodiphenylamine
	PAH-Derivatives {Polycyclic aromatic hydrocarbon derivatives designation}
	PAHs {Polycyclic aromatic hydrocarbons}
	PAHs, total, w/o individ. components reported
	PAHs, total, with individ. components also reported
1336363	PCBs {Polychlorinated biphenyls}
59961	Phenoxybenzamine
63923	Phenoxybenzamine hydrochloride
57410	Phenytoin
18378897	Plicamycin
CA-1155	Polybrominated biphenyls {PBBs}
	Polychlorinated dibenzo-*p*-dioxins {PCDDs or Dioxins}
	Polychlorinated dibenzofurans {PCDFs or Dibenzofurans}
CA-1156	POM {Polycyclic organic matter}
3564098	Ponceau 3R
3761533	Ponceau MX
129000	Pyrene
50555	Reserpine

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CAS	Chemical Name
132274	Sodium o-phenylphenate
10048132	Sterigmatocystin
54965241	Tamoxifen citrate
846504	Temazepam
28911015	Triazolam
78308	Triorthocresyl phosphate
115866	Triphenyl phosphate
101020	Triphenyl phosphite
72571	Trypan blue
143679	Vinblastine sulfate
2068782	Vincristine sulfate

APPENDIX B

EPA METHOD 9 INSTRUCTIONS FOR OPACITY READINGS

INSTRUCTIONS FOR USE OF THE VISIBLE EMISSION OBSERVATION FORM

INTRODUCTION

Federal Reference Method 9 - Visible Determination of the Opacity of Emissions from Stationary Sources (Federal Register 39 39872, November 12, 1974) requires the recording of certain specific information in the field documentation of a visible emission observation. The required information includes the name of the plant, the emission location, the type of facility, the observer's name and affiliation, the date, the time, the estimated distance to the emission location, the approximate wind direction, the estimated wind speed, a description of the sky conditions, the plume background, in addition to a minimum of 24 opacity observations.

Field experience gained from past use of Method 9 in determining compliance of sources subject to opacity standards has demonstrated a need for additional documentation when making visible emissions (VE) observations. The attached Visible Emissions Observation Form was developed to assist in the collection of information required by Method 9 and suggested additional information. The form was developed after a review of the opacity forms in use in EPA Regional Offices and State and local air quality control agencies. The form includes not only the data required by Method 9, but also more descriptive information on observation conditions.

The Visible Emissions Observation Form as designed is a three-part form; the top copy (original) goes to the agency files, the second copy is for the VE observer's file, and it is intended that the third copy be given to the appropriate facility personnel immediately following the onsite field observation if this is the agency policy or procedure. The forms are numbered serially with a 5-digit number and each copy of the three part form is imprinted with the same number. The form should be completed onsite and signed by the observer. It is recommended that waterproof black ink always be used with these forms.

The Visible Emissions Observation form (see Figure 1) can be functionally divided into 10 major sections, with each section documenting one or two aspects of the opacity determination. An "additional information" section is included for notation of relevant information not covered elsewhere on the form. Spaces for temporal change entries (e.g. "start," end" and the "comments" section of the data set) are used to record new information when the observation conditions change during the observation period.

The following guidelines discuss the major sections and each data element found on the VE observation Form. This includes a short explanation of each section's purpose, an explanation of each data element, a description of the type of information being sought, and in some cases, examples of appropriate entries. Discussions are keyed to Figure 1 by corresponding capital letters, and starred items indicate that the information is <u>required</u> by Method 9.

Separate companion forms including a company notification record and sheets for data reduction calculations are being prepared to accompany the VE Observation Form. To tie all these forms together, all companion forms will include a space for recording the 5-digit number(s) of the VE Observation Form(s) to which they relate. Each companion form will be accompanied by a set of instructions, which like the instructions which follow, will address each data element on the form and will include examples of appropriate entries.

A. COMPANY IDENTIFICATION. Provides information that uniquely identifies the company and permits the observer to locate or make contact with the company.

COMPANY NAME		
STREET ADDRESS		
CITY	STATE	ZIP
PHONE (KEY CONTACT)	SOURCE ID NUMBER	

Company Name* - Include the facility's complete name. For positive identification of the facility, the parent company name, division, or subsidiary name should be included.

Street Address* - Indicate the street address of the facility (not the mailing address or the home office address) so that the exact physical location of the source is known. If necessary, the mailing address or home office address may be listed elsewhere.

Phone (Key Contact) - List the phone number for the appropriate contact person at the facility such as the plant manager or environmental officer.

Source ID Number - This space is provided for the use of agency personnel and may be used to enter the number the agency uses to identify that particular source, such as the State file number, Compliance Data System number, or National Emission Data System number.

B. PROCESS AND CONTROL DEVICE TYPE. Includes a several-word descriptor of the process and control device, indication of current process operating capacity or mode, and operational status of control equipment. Note: This section, in particular, includes information that will probably have to be obtained from a plant official. EPA personnel asking a plant official for information requires the approval of OMB, an active case investigation, or a prominent disclaimer that the official is under no obligation to answer. Since a facility may consider their production rate or other process information as proprietary, the inspector shall specifically inform them that they have the right to request that this information be submitted subject to the "confidential business information" provisions of 40 CFR 2 Subpart B.

* Required by Reference Method 9; other items recommended.

PROCESS EQUIPMENT	OPERATING MODE
CONTROL EQUIPMENT	OPERATING MODE

Process Equipment* - Enter a description which clearly identifies the process equipment and type of facility that emits the plume or emissions to be read. The description should be brief, but should include as much information as possible, as indicated in the following examples:

- Coal-Fired Boiler - Unit 4/Power Plant
- #2 Oil-Fired Boiler/Chemical Plant
- Wood Waste Conical Incinerator
- Paint Spray Booth/Auto Plant
- Primary Crusher at Rock Quarry
- Fiberglass Curing Oven
- Reverb Furnace/Copper Smelter
- Basic Oxygen Furnace/Steel Mill
- Cement Plant Kiln

Operating Mode - Depending on the type of process equipment, this information may vary from a quantification of the current operating rate or a description of the portion of a batch-type process for which the emission opacity is being read to an explanation of how the equipment is currently operating such as "upset conditions," "startup," or "shutdown." Other examples include "90 percent capacity" for a boiler or "85 percent production rate" for the shakeout area of a grey iron foundry. For a steel making furnace, entries should include the exact part of the process cycle for which readings are being made, such as "charging" or "tapping." In most cases, this information will have to be obtained from a plant official.

Control Equipment* - Specify the type(s) of control equipment being used in the system after the process equipment in question (e.g., "hot-side electrostatic precipitator").

Operating Mode - Indicate the manner in which the control equipment is being utilized at the time of the opacity observations (e.g., 1 field of 8 tripped on ESP, scrubber operating without water, shut down, off line) and the operating mode (e.g., automatic, manual, bypass). This information should be obtained from a plant official.

C. EMISSION POINT IDENTIFICATION. Contains information uniquely identifying the emission point and its spatial relationship with the observer's position. It is recommended that distances and heights in this section be noted in consistent units.

DESCRIBE EMISSION POINT	
HEIGHT ABOVE GROUND LEVEL	HEIGHT RELATIVE TO OBSERVER Start End
DISTANCE FROM OBSERVER Start End	DIRECTION FROM OBSERVER Start End

Describe Emission Point* - Describe the type and physical characteristics of the emission point. The description must be specific enough so that the emission outlet can be distinguished from all others at the source. The description of the type of emission point should address whether it is (1) a specifically designed outlet such as tacks, vents, and roof monitors (having confined emissions) or (2) an emission source having unconfined emissions such as storage piles, chemical tanks, and non-ducted material handling operations. Description of the physical characteristics of the emission point should include the appearance (such as color, texture, etc.) and geometry (size, shape, etc.) of the stack or other outlet, and its location in relation to other recognizable facility landmarks.

Any special identification codes the agency or source uses to identify a particular stack or outlet should be noted along with the description; the source of the code should also be recorded. A special identification code should not be used alone to describe the emission point, since they are sometimes incorrect and also require a secondary reference. The observer must be certain of the origin of the emissions that were being read. A description of the emission point coupled with the identification of the process equipment and control equipment should accomplish that purpose.

Height Above Ground Level * - Indicate the height of the stack or other emission outlet from its foundation base. This information is usually available from agency files, engineering drawings, or computer printouts (such as NEDS printouts). The information may also be obtained by using a combination of a rangefinder and an Abney level or clinometer. The height may also be estimated.

Height Relative to Observer * - Indicate an estimate of the height of the stack outlet (or of any other type of emission outlet) above the position of the observer. This measurement indicates the observer's position in relation to the stack base (i.e. higher or lower than the base) and is necessary if slant angle calculations are performed.

Distance from Observer * - Record the distance from the point of observation to the emission outlet. This measurement may be made by using a rangefinder. A map may also be used to estimate the distance.

This measurement must be reasonably accurate when the observer is close to the stack (within 3 stack heights) because it may be used in conjunction with the outlet height relative to the observer to determine the slant angle at which the observations are made. A precise determination of the slant

* Required by Reference Method 9; other items recommended.

angle becomes important in calculating the positive bias inherent in opacity readings made when the observer is within three stack heights of the stack.

Direction From Observer * - Specify the direction of the emission point from the observer. It is suggested that this be done to the closest of the eight points of the compass (e.g. S, SE, NW, NE) and that a compass be used to make the determination. To accomplish this: hold the compass while facing the emission point; rotate the compass until the North compass point lies directly beneath the needle (which will be pointing towards magnetic North); then the point of the compass closest to the emission outlet will indicate the direction (Figure 3). A map may also be used to make this determination.

D. EMISSIONS DESCRIPTION. Includes information that definitely establishes what was observed while making the visible emissions determination. Note: Items called for in this section may change a number of times during the observation period. It is recommended that these changes be noted in the Comment space beside the appropriate opacity readings and reference to this be made in the corresponding space in this section.

DESCRIBE EMISSIONS Start		End	
EMISSION COLOR Start	End	IF WATER DROPLET PLUME Attached ☐	Detached ☐
POINT IN THE PLUME AT WHICH OPACITY WAS DETERMINED Start		End	

Describe Emissions* - Include the physical characteristics and behavior of the plume (not addressed elsewhere on the form) and the distance it is visible. Physical descriptions may include such things as texture, gradation, and contents, examples are "lacy," "fluffy," "copious," "mushrooming," "spreading over horizon," and "detached nonwater vapor condensibles." The standard plume terminology illustrated in Figure 4 may be used to describe plume behavior. The behavior is generally used to determine the atmospheric stability on the day of the opacity observations.

Emission Color* - Note the color of the emissions. The plume color can sometimes be useful in determining the composition of the emissions and also serves to document the total contrast between the plume and its background as seen by the opacity observer. For emissions that change color a number of times during the observation period (such as those from a basic oxygen furnace), the color changes should be noted in the comments space next to the opacity readings themselves.

If Water Droplet Plume* - This box is only completed if visible water droplets are present. Check "attached" if condensation of the moisture contained in the plume occurs within the stack and the water droplet plume is visible at the stack exit. Check "detached" if condensation occurs some distance downwind from the stack exit and the water droplet plume and the stack appear to be unconnected.

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* Required by Reference Method 9; other items recommended.

Plumes containing condensed water vapor ("water droplet plumes" or "steam plumes") are usually very white and billowy, and then wispy at the point of dissipation, where the opacity decreases rapidly from a high value (usually 100%) to zero if there is not residual opacity contributed by the contaminate in the plume.

To document the presence or absence of condensed water vapor in the plume, two points must be addressed. First, is sufficient moisture present (condensed or uncondensed) in the effluent to produce water droplets at in-stack or ambient conditions? Second, if enough moisture is present, are the in-stack and ambient conditions such that it will condense either before exiting the stack or after exiting (when it meets with the ambient air)? The first question can be answered by examining the process type and/or the treatment of the effluent gas after the process. Some common sources or moisture in the plume are:

- Water produced by combustion fuels,
- Water from dryers,
- Water introduced by wet scrubbers,
- Water introduced for gas cooling prior to an electrostatic precipitator or other control device, and
- Water used to control temperature of chemical reactions.

If water is present in the plume, data from a sling psychrometer, which measures relative humidity, in combination with the moisture content and temperature of the effluent gas can be used to predict whether the formation of a steam plume is probable.

Point in the Plume at Which Opacity Was Determined* - Describe as accurately as possible the physical location in the plume such as the distance from the emission point where the observations were made. This is necessary to establish that nothing interfered with the observer's clear view of the contaminant plume itself, such as condensed water vapor; it is also important in the case of secondary plume formation. Therefore, the observer must specify 1) if the readings were made prior to water droplet plume formation or after water droplet plume dissipation and 2) the distance from the emission point and/or water droplet plume. Descriptions such as "4 feet above outlet" and "80 feet downstream from outlet," "10 feet after steam dissipation" are appropriate. Figure 5 shows some examples of the correct location for making opacity readings in various steam plume and secondary plume situations.

E. OBSERVATION CONDITIONS. Covers the background and ambient weather conditions that occur during the observation period and could affect observed opacity.

DESCRIBE PLUME BACKGROUND Start		End		
BACKGROUND COLOR Start	End	SKY CONDITIONS Start	End	
WIND SPEED Start	End	WIND DIRECTION Start	End	
AMBIENT TEMP Start	End	WET BULB TEMP		RH Percent

Describe Plume Background* - Describe the background that the plume is obscuring and against which the opacity is being read. When describing the background, include characteristics such as texture. Examples of background descriptions are "structure behind roof monitor," "stand of pine trees," "edge of jagged stony hill side," "clear blue sky, " "stack scaffolding," and "building obscured by haze."

Background Color* - Describe the background color including the shade of the color (e.g., new leaf green, conifer green, dark brick red, sky blue, and light gray stone). In general, the background chosen to read against should contrast with the color of the plume.

Sky Conditions* - Indicate the percent cloud cover of the sky. This information can be indicated by using straight percentages (e.g., 10% overcast, 100% overcast) or by description, as shown below:

Term	Amount of Cloud Cover
Clear	< 10%
Scattered	10% to 50%
Broken	50% to 90%
Overcast	> 90%

Wind Speed* - Record the wind speed. It is recommended that it be measured or estimated to + or - 5 miles per hour. The wind speed may be measured using a hand-held anemometer (if available), or it can be estimated by using the Beaufort Scale of Wind Speed Equivalents shown in Table 1.

TABLE 1. THE BEAUFORT SCALE OF WIND SPEED EQUIVALENTS

General Description	Specifications	Limits of Velocity 33 ft (10 m) above Level ground, mph
Calm	Smoke rises vertically	Under 1
	Direction of wind shown by smoke drift but not by wind vanes	1 to 3
Light	Wind felt on face; leaves rustle; ordinary vane moved by wind	4 to 7
Gentle	Leaves and small twigs in constant motion; wind extends light flag	8 to 12
Moderate	Raises dust and loose paper; small branches are moved	13 to 18
Fresh	Small trees in leaf begin to sway; crested wavelets form on inland waters	19 to 24
	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty	25 to 31

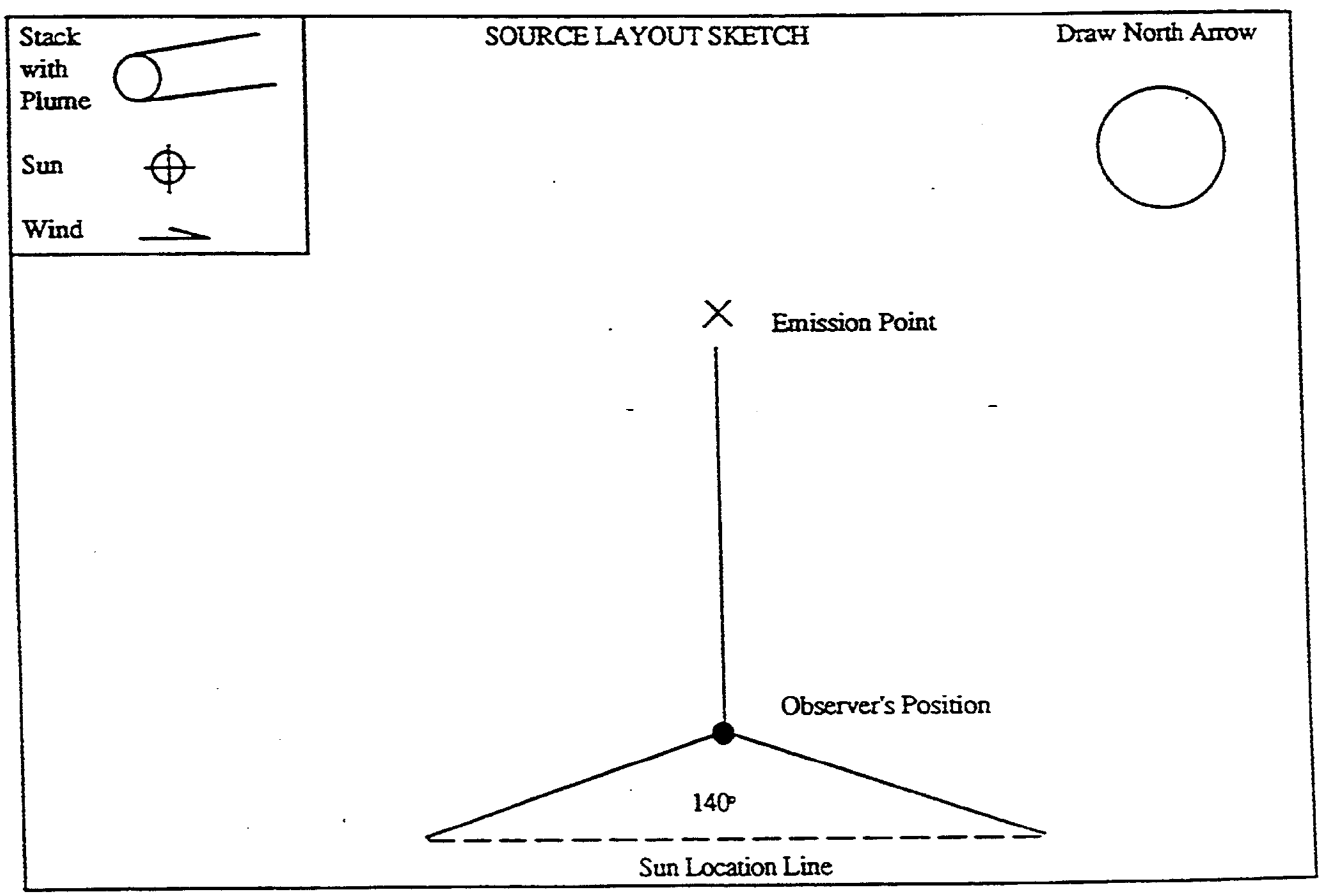
Wind Direction* - Indicate the direction from which the wind is blowing. It is suggested that the direction should be estimated to eight points of the compass. This can be accomplished by observing which way the plume is blowing. If this is not possible, the wind direction may be determined by observing a blowing flag or by noting the direction a few blades of grass or handful of dust are blown when tossed into the air. Keep in mind that the wind direction at the observation point may be different from that at the emission point; the wind direction at the emission point is the one of interest.

Ambient Temperature* - The outdoor temperature at the plant site is measured by a thermometer (in degrees Fahrenheit or centigrade). Be certain to note which temperature scale is used. The ambient temperature is used in conjunction with the wet bulb temperature when there are indications of a condensing water droplet plume.

Wet Bulb Temperature - Record the wet bulb temperature from the sling psychrometer. This is done when there is a possibility of a condensing water droplet plume.

Relative Humidity - Enter the relative humidity measured by using a sling psychrometer in conjunction with a psychrometric chart. This information is used to determine if water vapor in the plume will condense to form a steam plume.

F. OBSERVER POSITION AND SOURCE LAYOUT. Clearly identifies the observer's position in relation to the emission point, plant landmarks, topographic features, sun position, and wind direction.



Source Layout Sketch * - This sketch should be drawn as a rough plan view and should include as many landmarks as possible. At the very least, the sketch should locate the relative positions of the observed outlet and associated buildings in such a way that they will not be confused with others at a later date, and clearly locate the position of the observer while making the VE readings. The exact landmarks will depend on the specific source, but they might include:

- Other Stacks
- Mills
- Roads
- Fences
- Buildings
- Stockpiles
- Rail heads
- Tree lines
- Background for readings
- Interfering plumes from other sources

To assist in subsequent analysis of the reading conditions, sketch in the plume (indicate the direction of wind travel). The wind direction also must be indicated in the previous section.

Draw North Arrow - To determine the direction of north, point the line of sight in the source layout sketch in the direction of the actual emission point, place the compass next to the circle and draw an arrow in the circle parallel to the compass needle (which points north). A map may also be used to determine direction to north.

Sun's Location - It is important to verify this parameter before making any opacity readings. The sun's location should be within the 140° sector indicated in the layout sketch; this confirms that the sun is within the 140° sector to the observer's back.

To draw the sun's location, point the line of sight in the source layout sketch in the direction of the actual emission point, move a pen upright along the "sun location line" until the shadow of the pen falls across the observer's position. Then draw the sun at the point where the pen touches the "sun location line."

ADDITIONAL INFORMATION - Includes conditions and/or deviations of a factual nature that have bearing on the opacity observations and that cannot be addressed elsewhere on the form.

ADDITIONAL INFORMATION

Additional Information - Note conditions or deviations of a factual nature that cannot be addressed elsewhere on the form such as in the comments section of the data set. These must be purely factual in nature and specific to the particular source. Examples of information that may be included in this section are:

- Description of unusual stack configuration (to show multiple stacks or stack in relation to roof line); attach drawing, if necessary.
- References to attachments.

- Observed or reported changes to the emissions or process during observation that are not noted in the comments area of the form.
- Additional source identification information.

H. DATA SET. Opacity readings for the observation period, organized by minute and second. This section also includes the actual date and start and end times for the observation period and space next to each minute of readings for noting relevant comments.

OBSERVATION DATE			START TIME		END TIME
SEC / MIN	0	15	30	45	COMMENTS
1					
2					
3					
26					
27					
28					
29					
30					

Observation Date* - Enter the date on which the opacity observations were made.

Start Time, End Time* - Indicate the times at the beginning and the end of the actual observation period. The times may be expressed in 12-hour or 24-hour time (i.e., 8:35 a.m. or 0835); however, 24-hour time tends to be less confusing.

Data Set* - Spaces are provided on one form for entering an opacity reading every 15 seconds for up to a 30-minute observation period. If observations continue beyond 30 minutes, a second form (and third, etc.) should be used to record additional readings. The readings should be in percent opacity and made to the nearest 5 percent. The readings are entered from left to right for each numbered minute, beginning at the upper left corner of the left-hand column, labeled row "MIN 1" (minute 1) and column "SEC 0" (0 seconds). The next readings are entered consecutively in the spaces labeled MIN 1, SEC 15; MIN 1, SEC 30; MIN 1, SEC 45; MIN 2, SEC 0; MIN 2, SEC 15; etc.

If for any reason, a reading is not made for a particular 15-second period, a dash (-) should be placed in the space showing that the space is not just an oversight. The comment section beside that reading should be used for an explanation of why the reading was missed.

Comments - Spaces for comments are provided next to the data for each minute of opacity readings. These are intended to provide space to note changing observation conditions and/or reasons for missed readings in direct conjunction with the readings themselves. Items to be noted include:

- Changes in ambient conditions from the time of the start of readings
- Changes in plume color, behavior, or other characteristics
- Presence of interfering plumes from other sources
- Changes in observer position and indication that a new form is initiated
- Conditions that might interfere with readings or cause them to be biased high or low
- Unusual process conditions
- Reasons for missed readings

I. OBSERVER DATA. Information required to validate the opacity data.

OBSERVER'S NAME (PRINT)	
OBSERVER'S SIGNATURE	DATE
ORGANIZATION	
CERTIFIED BY	DATE

* Required by Reference Method 9; other items recommended.

Observer's Name* - Print observer's entire name.

Observer's Signature - Self-explanatory.

Date - Enter the date on which the form was signed.

Organization* - Provide the name of the agency or company that employs the observer.

Certified By - Identify the agency, company, or other organization that conducted the "smoke school" or VE training and certification course where the observer obtained his/her current certification.

Date* - Provide the date of the current certification.

J. FORMS INTERRELATION. Provides space for recording another VE Observation Form number so that forms concerning the same observation can be interrelated.

CONTINUED ON VEO FORM NUMBER					

Continued on VEO Form Number - Fill in the 5-digit number of the VE Observation Form, if any, where the observations from the form in use are continued. Each form of a series that has a form coming after it will have the number of the next form noted in this section.

* Required by Reference Method 9; other items recommended.

APPENDIX C

CALIFORNIA AIR POLLUTION DISTRICTS'
LIST OF POLYESTER RESIN FIBERGLASS RULES'
WEBSITE ADDRESSES

APPENDIX C

1. Bay Area Air Quality Management District:

   Regulation 8 - Organic compounds/Rule 50 - Polyester Resin Operations

   http://arbis.arb.ca.gov/drdb/ba/curhtm/r8-50.htm

   Regulation 1 - General Provisions and Definitions

   http://arbis.arb.ca.gov/drdb/ba/curhtm/reg-1-0.htm

2. Colusa County Air Pollution Control District:

   Regulation II - Prohibitions

   Rule 2.37 - Polyester Resin Operations

   http://arbis.arb.ca.gov/drdb/col/curhtml/r2-37.htm

   Rule 1.2 Definitions

   http://arbis.arb.ca.gov/drdb/col/curhtml/r1-2.htm

3. Sacramento Metropolitan Air Quality Management District

   Rule 465 - Polyester Resin Operations

   http://arbis.arb.ca.gov/drdb/sac/curhtml/r465.htm

   Rule 101 - General Provisions

   http://arbis.arb.ca.gov/drdb/sac/curhtml/r101.htm

4. Santa Barbara County Air Pollution Control District

   Rule 349 - Polyester Resin Operations

http://arbis.arb.ca.gov/drdb/sb/curhtml/r349.htm

Rule 102 - Definitions

http://arbis.arb.ca.gov/drdb/sb/curhtml/r102.htm

5. South Coast Air Quality Management District

   Rule 1162 - Polyester Resin Operations

   http://arbis.arb.ca.gov/drdb/sc/curhtml/r1162.htm

   Rule 1171 - Solvent Cleaning Operations

   http://arbis.arb.ca.gov/drdb/sc/curhtml/r1171.htm

6. San Diego County Air Pollution Control District

   Rule 67.12 - Polyester Resin Operations

   http://arbis.arb.ca.gov/drdb/sd/curhtml/r67-12.htm

   Rule 2 - Definitions

   http://arbis.arb.ca.gov/drdb/sd/curhtml/r2.htm

7. Shasta County Air Quality Management District

   Rule 3.13 - Polyester Resin Operations

   http://arbis.arb.ca.gov/drdb/sha/curhtml/r3-13.htm

   Rule 1.2 - Definitions

   http://arbis.arb.ca.gov/drdb/sha/curhtml/r1-2.htm

APPENDIX C

8. San Joaquin Valley Unified Air Pollution Control District

   Rule 4684 - Polyester Resin Operations

   http://arbis.arb.ca.gov/drdb/sju/curhtml/r4684.htm

   Rule 1020 - Definitions

   http://arbis.arb.ca.gov/drdb/sju/curhtml/r1020.htm

9. Yolo-Solano Air Quality Management District

   Rule 2.30 - Polyester Resin Operations

   http://arbis.arb.ca.gov/drdb/ys/curhtml/r2.30.htm

10. Ventura County Air Pollution Control District

    Rule 74.14 - Polyester Resin Material Operations

    http://arbis.arb.ca.gov/drdb/ven/curhtml/r74-14.htm

    Rule 2 - Definitions

    http://arbis.arb.ca.gov/drdb/ven/curhtml/r2.htm

APPENDIX D

SAN JOAQUIN VALLEY UNIFIED APCD
DEMINIMUS LEVELS FOR HAZARDOUS AIR POLLUTANTS

Attachment III - Deminimus Levels for Hazardous Air Pollutants

Note: The listed deminimus levels are only to be used for hazardous air pollutants that do not have OEHHA approved Risk values.

CAS#	Chemical Name	De Minimis Level (tons/year)	Basis
57147	1,1-Dimethyl hydrazine	0.008	UR
79005	1,1,2-Trichloroethan	1	UR
79345	1,1,2,2-Tetrachloroethane	0.3	UR
96128	1,2-Dibromo-3-chloropropane	0.01	UR
122667	1,2-Diphenylhydrazine	0.09	UR
106887	1,2-Epoxybutane	1	DEF=1
75558	1,2-Propyleneimine (2-Methyl aziridine)	0.003	UR
120821	1,2,4-Trichlorobenzene	10	CAP-RfC
106990	1,3-Butadiene	0.07	UR
542756	1,3-Dichloropropene	1	DEF=1
1120714	1,3-Propane sultone	0.03	UR
106467	1,4-Dichlorobenzene(p)	3	UR
123911	1,4-Dioxane (1,4-Diethyleneoxide)	6	UR
53963	2-Acetylaminofluorine	0.005	UR
532274	2-Chloroacetophenone	0.06	RfC
79469	2-Nitropropane	1	DEF=1
540841	2,2,4 - Trimethylpentane	5	DEF=5
1746016	2,3,7,8-Tetrachlorodibenzo-p-dioxin	6E-07	UR
584849	2,4 - Toluene diisocyanate	0.1	ACUTE
51285	2,4-Dinitrophenol	1	CS
121142	2,4-Dinitrotoluene	0.02	UR
94757	2,4-D, salts, esters(2,4-Dichlorophenoxy acetic acid)	10	CS
95807	2,4-Toluene diamine	0.02	UR
95954	2,4,5-Trichlorophenol	1	DEF=1
88062	2,4,6-Trichlorophenol	6	UR
91941	3,3-Dichlorobenzidene	0.2	UR
119904	3,3'-Dimethoxybenzidine	0.1	UR
119937	3,3'-Dimethyl benzidine	0.008	UR
92671	4-Aminobiphenyl	1	DEF=1
92933	4 - Nitrobiphenyl	1	DEF=1

CAS#	Chemical Name	De Minimis Level (tons/year)	Basis
101779	4,4'-Methylenedianiline	1	DEF=1
534521	4,6-Dinitro-o-cresol, and salts	0.1	ACUTE
75070	Acetaldehyde	9	UR
60355	Acetamide	1	DEF=1
75058	Acetonitrile	4	RfC
98862	Acetophenone	1	CS
107028	Acrolein	0.04	RfC
79061	Acrylamide	0.02	UR
79107	Acrylic acid	0.6	RfC
107131	Acrylonitrile	0.3	UR
107051	Allyl chloride	1	DEF=1
62533	Aniline	1	UR
71432	Benzene	2	UR
92875	Benzidine	0.0003	UR
98077	Benzotrichloride	0.006	UR
100447	Benzyl chloride	0.1	ACUTE
57578	beta-Propiolactone	0.1	ACUTE
92524	Biphenyl	10	CS
117817	Bis(2-ethylhexyl)phthalate (DEHP)	5	UR
542881	Bis(chloromethyl)ether	0.0003	UR
75252	Bromoform	10	CAP-UR
156627	Calcium cyanamide	10	CS
105602	Caprolactam	10	CS
133062	Captan	10	CAP-UR
63252	Carbaryl	10	CS
75150	Carbon disulfide	1	CS
56235	Carbon tetrachloride	1	UR
463581	Carbonyl sulfide	5	DEF=5
120809	Catechol	5	DEF=5
133904	Chloramben	1	DEF=1
57749	Chlordane	0.01	GWP
7782505	Chlorine	0.1	ACUTE
79118	Chloroacetic acid	0.1	ACUTE
108907	Chlorobenzene	10	CS
510156	Chlorobenzilate	0.4	UR

CAS#	Chemical Name	De Minimis Level (tons/year)	Basis
67663	Chloroform	0.9	UR
107302	Chloromethyl methyl ether	0.1	ACUTE
126998	Chloroprene	1	DEF=1
1319773	Cresols/Cresylic acid (isomers and mixture)	1	DEF=1
95487	o-Cresol	1	DEF=1
108394	m-Cresol	1	DEF=1
106445	p-Cresol	1	DEF=1
98828	Cumene	10	CS
334883	Diazomethane	1	DEF=1
132649	Dibenzofuran	5	DEF=5
72559	DDE (p,p'-Dichlorodiphenyldi-chloroethylene)	0.01	GWP
84742	Dibutylphthalate	10	CS
111444	Dichloroethyl ether (Bis(2-chloroethyl)ether)	0.06	UR
62737	Dichlorvos	0.2	UR
111422	Diethanolamine	5	DEF=5
64675	Diethyl sulfate	1	DEF=1
60117	Dimethyl aminoazobenzene	1	DEF=1
79447	Dimethyl carbamoyl chloride	0.02	UR
68122	Dimethyl formamide	1	DEF=1
131113	Dimethyl phthalate	10	CS
77781	Dimethyl sulfate	0.1	ACUTE
106898	Epichlorohydrin	2	RfC
140885	Ethyl acrylate	1	UR
100414	Ethyl benzene	10	CAP-RfC
51796	Ethyl carbamate (Urethane)	0.8	UR
75003	Ethyl chloride	10	CAP-RfC
106934	Ethylene dibromide (Dibromoethane)	0.1	UR
107062	Ethylene dichloride (1,2-Dichloroethane)	0.8	UR
107211	Ethylene glycol	10	CS
151564	Ethylene imine (Aziridine)	0.003	UR
75218	Ethylene oxide	0.1	ACUTE
96457	Ethylene thiourea	0.6	UR
75343	Ethylidene dichloride (1,1-Dichloroethane)	1	DEF=1

CAS#	Chemical Name	De Minimis Level (tons/year)	Basis
75741	Tetramethyl lead	0.01	GWP
78002	Tetraethyl lead	0.01	GWP
7439965	Manganese and compounds (except those specifically listed)*	0.8	RfC
12108133	Methylcyclopentadienyl manganese	0.1	ACUTE
-	Mercury compounds (except those specifically listed)*	0.01	GWP
10045940	Mercuric nitrate	0.01	GWP
748794	Mercuric chloride	0.01	GWP
62384	Phenyl mercuric acetate	0.01	GWP
-	Elemental Mercury	0.01	GWP
-	Mineral fiber compounds (except those specifically listed)*	a	-
1332214	Asbestos	a	-
-	Erionite	a	-
-	Silica (crystalline)	a	-
-	Talc (containing asbestos form fibers)	a	-
-	Glass wool	a	-
-	Rock wool	a	-
-	Slag wool	a	-
-	Ceramic fibers	a	-
-	Nickel compounds (except those specifically listed)*	1	DEF=1
13463393	Nickel Carbonyl	0.1	ACUTE
12035722	Nickel refinery dust	0.08	UR
-	Nickel subsulfide	0.04	UR
-	Polycyclic organic matter-POM (except those specifically listed)*	0.01	GWP
56553	Benz(a)anthracene	0.01	GWP
50328	Benzo(a)pyrene	0.01	UR
205992	Benzo(b)fluoranthene	0.01	GWP
57976	7,12-Dimethylbenz(a)anthracene	0.01	GWP
225514	Benz(c)acridine	0.01	GWP
218019	Chrysene	0.01	GWP
53703	Dibenz(ah)anthracene	0.01	GWP
189559	1,2:7,8-Dibenzopyrene	0.01	GWP
193395	Indeno(1,2,3-cd)pyrene	0.01	GWP
-	Dioxins & Furans (TCDD equivalent) **	-	UR
7782492	Selenium and compounds (except those specifically listed)*	0.1	CS

CAS#	Chemical Name	De Minimis Level (tons/year)	Basis
108383	m-Xylenes	10	CS
95476	o-Xylenes	10	CS
106423	p-Xylenes	10	CS
	CHEMICAL COMPOUND CLASSES		
-	Arsenic and inorganic arsenic compounds	0.005	UR
7784421	Arsine	0.005	UR
-	Antimony compounds (except those specifically listed)*	5	DEF=5
1309644	Antimony trioxide	1	DEF=1
1345046	Antimony trisulfide	0.1	CS
7783702	Antimony pentafluoride	0.1	ACUTE
28300745	Antimony potassium tartrate	1	CS
-	Beryllium compounds (except Beryllium salts)	0.008	UR
-	Beryllium salts	0.00002	UR
-	Cadmium compounds	0.01	UR
130618	Cadmium oxide	0.01	UR
-	Chromium compounds (except Hexavalent and Trivalent)	5	DEF=5
-	Hexavalent Chromium compounds	0.002	UR
-	Trivalent Chromium compounds	5	DEF=5
10025737	Chromic chloride	0.1	ACUTE
744084	Cobalt metal (and compounds, except those specifically listed)*	0.1	CS
10210681	Cobalt carbonyl	0.1	ACUTE
62207765	Fluomine	0.1	ACUTE
-	Coke oven emissions	0.03	UR
-	Cyanide compounds (except those specifically listed)*	5	DEF=5
143339	Sodium cyanide	0.1	ACUTE
151508	Potassium cyanide	0.1	ACUTE
-	Glycol ethers (except those specifically listed)*	5	DEF=5
110805	2-Ethoxy ethanol	10	CAP-RfC
111762	Ethylene glycol monobutyl ether	10	CAP-RfC
108864	2-Methoxy ethanol	10	CAP-RfC
-	Lead and compounds (except those specifically listed)*	0.01	GWP

CAS#	Chemical Name	De Minimis Level (tons/year)	Basis
69892	N-Nitrosomorpholine	1	DEF=1
684935	N-Nitroso-N-methylurea	0.0002	UR
121697	N,N-Dimethylaniline	1	CS
90040	o-Anisidine	1	DEF=1
95534	o-Toluidine	4	UR
56382	Parathion	0.1	ACUTE
82688	Pentachloronitrobenzene (Quintobenzene)	0.3	UR
87865	Pentachlorophenol	0.7	UR
108952	Phenol	0.1	CS
75445	Phosgene	0.1	ACUTE
7803512	Phosphine	5	DEF=5
7723140	Phosphorous	0.1	ACUTE
85449	Phthalic anhydride	5	DEF=5
1336363	Polychlorinated biphenyls (Aroclors)	0.009	UR
106503	p-Phenylenediamine	10	CS
123386	Propionaldehyde	5	DEF=5
114261	Propoxur (Baygone)	10	CAP-UR
78875	Propylene dichloride (1,2-Dichloropropane)	1	UR
75569	Propylene oxide	5	UR
91225	Quinoline	0.006	UR
106514	Quinone	5	DEF=5
100425	Styrene	1	DEF=1
96093	Styrene oxide	1	DEF=1
127184	Tetrachloroethylene (Perchloroethylene)	10	CAP-UR
7550450	Titanium tetrachloride	0.1	ACUTE
108883	Toluene	10	CAP-RfC
8001352	Toxaphene (chlorinated camphene)	0.01	GWP
79016	Trichloroethylene	10	CAP-UR
121448	Triethylamine	10	CAP-RfC
1582098	Trifluralin	9	UR
108054	Vinyl acetate	1	DEF=1
593602	Vinyl bromide (bromoethene)	0.6	UR
75014	Vinyl chloride	0.2	UR
75354	Vinylidene chloride (1,1-Dichloroethylene)	0.4	UR
1330207	Xylenes (isomers and mixture)	10	CS

CAS#	Chemical Name	De Minimis Level (tons/year)	Basis
50000	Formaldehyde	2	UR
76448	Heptachlor	0.02	UR
118741	Hexachlorobenzene	0.01	GWP
87683	Hexachlorobutadiene	0.9	UR
77474	Hexachlorocyclopentadiene	0.1	ACUTE
67721	Hexachloroethane	5	UR
822060	Hexamethylene, 1, 6 -diisocyanate	0.02	RfC
680319	Hexamethylphosphoramide	0.01	RfC
110543	Hexane	10	CAP-RfC
302012	Hydrazine	0.004	UR
7647010	Hydrochloric acid	10	CAP-RfC
7664393	Hydrogen fluoride	0.1	ACUTE
123319	Hydroquinone	1	DEF=1
78591	Isophorone	10	CAP-UR
58899	Lindane (hexachlorcyclohexane, gamma)	0.01	GWP
108316	Maleic anhydride	1	CS
67561	Methanol	10	CS
72435	Methoxychlor	10	CS
74839	Methyl bromide (Bromomethane)	10	RfC
74873	Methyl chloride (Chloromethane)	10	CAP-UR
71556	Methyl chloroform (1,1,1-Trichloroethane)	10	CS
78933	Methyl ethyl ketone (2-Butanone)	10	CAP-RfC
60344	Methyl hydrazine	0.06	UR
74884	Methyl iodide (Iodomethane)	1	DEF=1
108101	Methyl isobutyl ketone	10	CS
624839	Methyl isocyanate	0.1	ACUTE
80626	Methyl methacrylate	10	CS
1634044	Methyl tert-butyl ether	10	CAP-RfC
12108133	Methylcyclopentadienyl manganese	0.1	ACUTE
75092	Methylene chloride (Dichloromethane)	10	CAP-UR
101688	Methylene diphenyl diisocyanate	0.1	RfC
91203	Naphthalene	10	CS
98953	Nitrobenzene	1	CS
62759	N-Nitrosodimethylamine	0.001	UR

CAS#	Chemical Name	De Minimis Level (tons/year)	Basis
7488564	Selenium sulfide (mono and di)	0.1	CS
7783075	Hydrogen selenide	0.1	ACUTE
10102188	Sodium selenite	0.1	ACUTE
13410010	Sodium selenate	0.1	ACUTE
99999918	Radionuclides (including radon)	b	

Legend:

UR = Based on unit risk value
DEF=1 = Used for carcinogens where no UR exists
RfC = Based on reference concentration in IRIS
CS = Used where no RfC is listed in IRIS CS=1-20: De minimis=10
CS=21-40: De minimis=1; CS>40: De minimis=0.1
DEF=5 = Used where no UR, RfC, or CS exists
CAP = UR, or RfC yielded a value > 10 tons/year.
Thus a CAP of 10 tons/year was used.
IRIS = Integrated Risk Information System
@ = A verified RfC not yet on IRIS
GWP = Identified as of concern for persisitence by the Great Waters Program
RfC = Based on Inhalation reference concentration listed in IRIS
Acute = Identified as being of concern from short-term exposures

Notes:

* For this chemical group, specific compounds or subgroups are named specifically in this table. For the remainder of the chemicals of the chemical group, a single de minimis value is listed, this value applies to compounds which are not named specifically.

** The "toxic equivalent factor" method in EPA/625/3-89-016, [U.S. EPA (1989) Interim procedures for estimating risk associated with exposure to mixtures] should be used for PCDD/PCDF mixtures. A different de minimis level will be determined for each mixture depending on the equivalency factors used which are compound specific.

a De minimis values are zero pending public comment on the rule. Currently available data do not support assignment of a "trivial" emission rate, therefore, the value assigned will be policy based.

b The EPA relies on subpart B and I, and Appendix E of 40 CFR part 61 and assigns a de minimis level based on an effective dose equivalent of 0.3 millirem per year for a 7 year exposure period that would result in a cancer risk of 1 per million. The individual radionuclides subject to de minimis levels used for section 112(g) are also contained in 40 CFR part 61.

APPENDIX E

Polyester
Resin/
Fiberglass

BAY AREA AQMD TOXIC AIR CONTAMINANT TRIGGER LEVELS

Table 2-1-316
Toxic Air Contaminant Trigger Levels

Compound	CAS Number	Trigger Level (lb/year)
Acetaldehyde	75070	7.20E+01
Acrolein	107028	3.90E+00
Acrylamide	79061	1.50E-01
Acrylonitrile	107131	6.70E-01
Allyl chloride	107051	1.93E+02
Ammonia	7664417	1.93E+04
Arsenic and arsenic compounds (inorganic)	7440382*	2.40E-02
Asbestos	1332214	3.00E-03
Benzene	71432	6.70E+00
Benzidine (and its salts)	92875*	1.40E-03
Benzyl chloride (see chlorotoluenes)	100447	
Beryllium and beryllium compounds	7440417*	1.50E-02
Bis(chloromethyl)ether	542881	1.50E-02
Bromine and bromine compounds (inorganic)	7726956*	3.28E+02
Butadiene, 1,3-	106990	1.10E+00
Butyl alcohol, tert-	75650	1.37E+05
Cadmium and cadmium compounds	7440439*	4.60E-02
Carbon disulfide	75150	1.43E+04
Carbon tetrachloride	56235	4.60E+00
Chlorinated dibenzodioxins and dibenzofurans (TCDD equivalent)	1746016*	1.20E-06
Chlorine	7782505	1.37E+03
Chlorobenzene	108907	1.35E+04
Chlorofluorocarbons	*	1.35E+05
Chloroform	67663	3.60E+01
Chlorophenol, 2-	108430	3.47E+03
Chloropicrin	76062	3.28E+02
Chloroprene	126998	1.50E+03
Chlorotoluenes	100447*	2.32E+03
Chromium (hexavalent) and chromium (hexavalent) compounds	18540299*	1.40E-03
Copper and copper compounds	7440508*	4.63E+02
Cresol	1319773	3.47E+04
Dibromo-3-chloropropane,1,2- (DBCP)	96128	9.70E-02
Dichlorobenzene, 1,4-	106467	6.80E+01
Dichlorobenzidene, 3,3'-	91941	5.60E-01
Dichloroethylene, 1,1- (see vinylidene chloride)		
Diethylaminoethanol	100378	2.12E+04
Diethylhexylphthalate (DEHP)	117817	8.10E+01
Dimethyl phthalate	131113	2.32E+03
Dimethylamine	124403	3.86E+02
Dioctyl phthalate	117840	2.32E+03
Dioxane, 1,4-	123911	2.50E+01
Epichlorohydrin	106898	8.30E+00
Ethyl acetate	141786	6.56E+05
Ethyl acrylate	140885	9.26E+03
Ethyl alcohol (ethanol)	64175	8.69E+05
Ethyl chloride	75003	1.93E+06
Ethyl benzene	100414	1.93E+05
Ethylene dibromide (1,2-dibromoethane)	106934	2.70E+00

Compound	CAS Number	Trigger Level (lb/year)
Ethylene dichloride (1,2-dichloroethane)	107062	9.70E+00
Ethylene oxide	75218	2.10E+00
Formaldehyde	50000	3.30E+01
Freons (see Chlorofluorocarbons)		
Glutaraldehyde	111308	3.28E+02
Glycol ethers:		
2-Ethoxy ethanol (cellosolve; ethylene glycol monoethyl ether)	110805	3.86E+04
2-Ethoxyethyl acetate (cellosolve acetate; ethylene glycol monoethyl ether acetate)	111159	1.24E+04
2-Methoxy ethanol (methyl cellosolve; ethylene glycol monomethyl ether)	109864	3.86E+03
2-Methoxyethyl acetate (methyl cellosolve acetate; ethylene glycol monomethyl ether acetate)	110496	1.10E+04
2-Butoxy ethanol (Butyl cellosolve; ethylene glycol monobutyl ether)	111762	3.86E+03
Hexachlorobenzene	118741	3.90E-01
Hexachlorocyclohexanes	58899*	1.80E-01
Hexachlorocyclopentadiene	77474	4.63E+01
Hexane, n-	110543	8.30E+04
Hydrazine	302012	3.90E-02
Hydrogen bromide (hydrobromic acid)	10035106	4.63E+03
Hydrogen chloride	7647010	1.35E+03
Hydrogen cyanide	74908	1.35E+04
Hydrogen fluoride	7664393	1.14E+03
Hydrogen sulfide	7783064	8.11E+03
Isocyanates:		
Methylene-bis-phenyl isocyanate	101688	1.83E+01
Methyl isocyanate	624839	6.95E+01
Toluene diisocyanates	26471625*	1.83E+01
Isophorone	78591	6.56E+04
Isopropyl alcohol	67630	4.44E+05
Lead, inorganic, and lead compounds	7439921*	2.90E+01
Maleic anhydride	108316	4.63E+02
Manganese and manganese compounds	7439965*	7.70E+01
Mercury and mercury compounds (inorganic)	7439976*	5.79E+01
Methyl alcohol (methanol)	67561	1.20E+05
Methyl bromide	74839	1.16E+03
Methyl chloroform (1,1,1-TCA)	71556	6.18E+04
Methyl mercury	593748	1.93E+02
Methyl methacrylate	80626	1.89E+05
Methylene chloride	75092	1.90E+02
Methylene dianiline and its dichloride, 4,4'-	101779*	3.67E+02
Methylethylketone (MEK)	78933	1.49E+05
Methylpyrrolidone, N-	872504	1.83E+05
Naphthalene	91203	2.70E+02
Nickel and nickel compounds	7440020*	7.30E-01
Nitric acid	7697372	2.34E+03
Nitrobenzene	98953	3.28E+02
Nitropropane, 2-	79469	3.86E+03
Nitrosodiethylamine, N-	55185	1.90E-02
Nitrosodimethylamine, N-	62759	4.20E-02
Nitrosodi-n-butylamine, N-	924163	6.20E-02

Compound	CAS Number	Trigger Level (lb/year)
Nitrosodi-n-propylamine, N-	621647	9.70E-02
Nitrosodiphenylamine, p-	86306	7.30E+01
Nitrosomethylethylamine, N-	10595956	3.10E-02
Nitrosopyrrolidine, N-	930552	3.30E-01
PAHs (including but not limited to):	*	
Benz[a]anthracene	56553	4.30E-02
Benzo[b]fluoroanthene	205992	4.30E-02
Benzo[k]fluoroanthene	205823	4.30E-02
Benzo[a]pyrene	50328	4.30E-02
Dibenz[a,h]anthracene	53703	4.30E-02
Indeno[1,2,3-cd]pyrene	193395	4.30E-02
PCBs (polychlorinated biphenyls)	1336363*	7.00E-03
Pentachlorophenol	87865	4.20E+01
Perchloroethylene (tetrachloroethylene)	127184	3.30E+01
Phenol	108952	8.69E+03
Phosgene	75445	1.83E+02
Phosphine	7803512	1.93E+03
Phosphoric acid	7664382	4.63E+02
Phosphorus (white)	7723140	1.39E+01
Phthalic anhydride	85449	1.35E+06
Propylene oxide	75569	5.20E+01
Selenium and selenium compounds	7782492*	9.65E+01
Sodium hydroxide	1310732	9.26E+02
Styrene monomer	100425	1.35E+05
Tetrachlorophenols	25167833*	1.70E+04
Tetrahydrofuran	109999	2.70E+05
Toluene	108883	3.86E+04
Trichlorobenzene, 1,2,4-	120821	1.83E+04
Trichloroethane, 1,1,1- (see Methyl chloroform)		
Trichloroethylene	79016	9.70E+01
Trichlorophenol, 2,4,6-	88062	9.70E+00
Urethane (ethyl carbamate)	51796	6.60E-01
Vapam (sodium methyldithiocarbamate)	137428	2.20E+04
Vinyl chloride	75014	2.50E+00
Vinylidene chloride	75354	6.18E+03
Xylenes	1330207*	5.79E+04
Zinc and zinc compounds	7440666*	6.76E+03

* -- This is a chemical compound group. If a CAS number is listed, it represents only a single chemical within the chemical class (for metallic compounds, the CAS number of the elemental form is listed; for other compounds, the CAS number of a predominant compound in the group is given).

n/a --No CAS number is available for this compound or compound group.

If the emissions from a source are less than the listed trigger-levels, it is assumed that the source would not fail a risk screen. If the emissions are equal or greater than one or more of the trigger-levels, a risk screen should be completed to determine the source's exemption status.

APPENDIX F

BILL OF RIGHTS FOR ENVIRONMENTAL PERMIT APPLICANTS

BILL OF RIGHTS FOR ENVIRONMENTAL PERMIT APPLICANTS

California Environmental Protection Agency (Cal/EPA) recognizes that many complex issues must be addressed when pursuing reforms of environmental permits and that significant challenges remain. We have initiated reforms and intend to continue the effort to make environmental permitting more efficient, less costly, and to ensure that those seeking permits receive timely responses from the boards and departments of the Cal/EPA. To further this goal, Cal/EPA endorses the following precepts that form the basis of a permit applicant's Bill of Rights:

1. Permit applicants have the right to assistance in understanding regulatory and permit requirements. All Cal/EPA programs maintain an Ombudsman to work directly with applicants. Permit Assistance Centers located throughout California have permit specialists from State, regional, and local agencies to identify permit requirements and assist in permit processing.

2. Permit applicants have the right to know the projected fees for review of applications, how any costs will be determined and billed, and procedures for resolving any disputes over fee billings.

3. Permit applicants have the right of access to complete and clearly written guidance documents that explain the regulatory requirements. Agencies must publish a list of all information required in a permit application and of criteria used to determine whether the submitted information is adequate.

4. Permit applicants have the right of timely completeness determinations for their applications. In general, agencies notify the applicant within 30 days of any deficiencies or determine that the application is complete. California Environmental Quality Act (CEQA) and public hearing requests may require additional information.

5. Permit applicants have the right to know exactly how their applications are deficient and what further information is needed to make their applications complete. Pursuant to California Government Code Section 65944, after an application is accepted as complete, an agency may not request any new or additional information that was not specified in the original application.

6. Permit applicants have the right of a timely decision on their permit application. The agencies are required to establish time limits for permit reviews.

7. Permit applicants have the right to appeal permit review time limits by statute or administratively that have been violated without good cause. For state environmental agencies, appeals are made directly to the Cal/EPA Secretary or to a specific board. For local environmental agencies, appeals are generally made to the local governing board or, under certain circumstances, to Cal/EPA. Through this appeal, applicants may obtain a set date for a decision on their permit and in some cases a refund of all application fees (ask boards and departments for details).

8. Permit applicants have the right to work with a single lead agency where multiple environmental approvals are needed. For multiple permits, all agency actions can be consolidated under a lead agency. For site remediation, all applicable laws can be administered through a single lead agency.

9. Permit applicants have the right to know who will be reviewing their application and the time required to complete the full review process.

APPENDIX G

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